20

LEMMON, PAUL E. AND F. X. SCHUMACHER. 1/ INFORMATION ABOUT GROWTH AND YIELD OF PONDEROSA PINE THAT SUPPLEMENTS THE THREE PUBLISHED REPORTS LISTED BELOW:

Lemmon, Paul E. and F. X. Schumacher 1962a. Volume and diameter growth of ponderosa pine trees as influenced by site index, density, age, and size. Forest Science 8 (3):236-249, September.

_____1962b. Stocking density around ponderosa pine trees. Forest Science 8 (4): 397-402, December.

_____1963. Theoretical growth and yield of hypothetical ponderosa pine stands under different thinning regimes. Forest Science 9 (1): 33-43, March.

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FOREWORD

The three publications to which this supplementary information applies could not carry many details that may be important to certain readers. Some of the more important tables and detailed explanations of computations are included herewith. They are thus available in unpublished form. Credit should be given to the authors for use of any of this unpublished material.

CONTENTS

		Page
Explanation of	Table 7 and Figures 5,6, and 7	1
Table 7.	Comparison between total and dominant portion of even-aged natural stands of ponderosa pine	2
Figure 5.	Relationship between age and diameter of tree of average basal area for the dominant and co-dominant portion of unthinned even-aged ponderosa pine stands by site index classes	3
Figure 6.	Relationship between age and number of dominant and codominant trees per acre in even-aged ponderosa pine stands	4
Figure 7.	Relationship between age and basal area for the dominant and codominant portion of unthinned even-aged ponderosa pine stands by site index classes	5
Explanation of	Tables 7a and Figure 8	6
Table 7a.	Calculated reduction in basal area for different sites throughout the life of the dominant portion of unthinned, fully stocked stands of ponderosa pine, by application of the $(D+6)^2$ spacing formula	7
Figure 8.	Basal area of dominant stands after applying the $(D+6)^2$ spacing formula, for different site index classes, expressed as percent of that for the unthinned dominant stand	8
Explanation of	table 8	9
Table 8.	Ratio of average space occupied and square of the average diameter of dominant and codominant trees in fully stocked unmanaged ponderosa pine stands as influenced by age and site index	10
Explanation of	Tables 9 and 10, and Figure 9	11
Table 9.	Calculated reduction in basal area for different sites throughout the life of the dominant portion of unthinned fully stocked stands of ponderosa pine by application of the biological spacing formula , $(D+X)^2F$, using different values for X	12
Table 10.	Summary of basal area, expressed as percentage of that for unthinned dominant stand, by age, site index, and different degrees of thinning with the biological spacing rule	15
Figure 9.	Basal area of dominant stands of ponderosa pine after applying the biological spacing formula, $(D+X)^2F$, for different site indexes and for different values of the factor X, expressed as percent of that for the unthinned dominant stand	16
Explanation of	Table 11	17
Table 11.	Average of all basal area values at the ends of each growth interval beyond 50 years of age, expressed as percentage of the average basal area of the dominant portion of unthinned stands of comparable age	18

Explanation of Tables 12, 13, 14, 15, and 16 ---------- 19
Table 12. Calculated growth and yield for hypothetical ponderosa pine stands of site index 60 for four thinning regimes that give theoretical optimum production ---------- 21
Table 13. Same title as above but for site index 80------ 22
Table 14. Same title as above but for site index 100----- 23
Table 15. Same title as above but for site index 120----- 24
Table 16. Same title as above but for site index 140----- 25
Explanation of Tables 17,18, 19, 20, and 21---------- 26
Table 17. Calculated growth and yield for hypothetical ponderosa pine stands of site index 60 for three thinning regimes using the $(D+6)^2$ spacing formula ---------- 27
Table 18. Same title as above but for site index 80------- 28
Table 19. Same title as above but for site index 100------ 29
Table 20. Same title as above but for site index 120------ 30
Table 21. Same title as above but for site index 140------ 31
Explanation of volume equations---------- 32
Explanation of Appendix Table 1---------- 34a
Appendix Table 1. Individual tree measurements---------- 35
Explanation of stand control information---------- 50
Table 101. Stocking control of hypothetical even-aged ponderosa pine stands at site index 80 following thinning regimes with two spacing formulae---------- 53
Table 102. Required rates per acre per year of crop tree harvesting at the time of last thinning, to develop proper age-class distribution, assuming a rotation to the end of the 12-year thinning cycle in each case. Site index 80--- 54
Table 103. Stand control of ponderosa pine by recurring thinnings and crop tree harvesting---------- 55
Figure 101. Relation between crop tree harvesting rates and assumed rotation ages---------- 56
Figure 102. Calculated diameter growth of dominant and codominant ponderosa pine trees on different sites when freed to grow, recurringly, beginning at 10 inches d.b.h.---------- 57

EXPLANATION OF TABLE 7 AND FIGURES 5, 6, and 7

These tables are published in Forest Science 8: (3) 236-249, Sept. 1962 where a complete explanation of their development is found. They are included herewith for purposes of ready reference to those who may wish to use the other information. Figures 5, 6, and 7 represent curved information shown in Table 7.

Table 7.--Comparison between total and dominant portion of even-aged natural stands of Ponderosa pine1/

Age	Item2/	Site Index 40 Total	40 Dominant	60 Total	60 Dominant	80 Total	80 Dominant	100 Total	100 Dominant	120 Total	120 Dominant	140 Total	140 Dominant	160 Total	160 Dominant
20	No. trees per acre	---	---	4,600	1,213	2,250	903	1,280	407	779	256	561	197	394	145
	Basal area-sq. ft./acre	---	---	46	48	70	56	93	62	115	80	137	95	159	108
	Ave. diam.-inches	---	---	1.3	2.7	2.4	3.4	3.6	5.3	5.2	7.6	6.7	9.4	8.6	11.7
	Cu. ft. vol. per acre	---	---	400	xx	1,000	xx	1,700	xx	2,400	xx	3,350	xx	4,350	xx
	Bd. ft. vol. per acre 3/	---	---	---	xx	---	xx	600	xx	2,800	xx	7,300	xx	16,500	xx
40	No. trees per acre	6,960	2,348	2,700	946	1,270	430	785	274	539	203	405	162	316	138
	Basal area-sq. ft./acre	123	101	151	111	180	126	210	148	238	164	264	181	287	200
	Ave. diam.-inches	1.8	2.8	3.2	4.6	5.1	7.3	7.0	10.0	9.0	12.2	10.9	14.3	12.9	16.3
	Cu. ft. vol. per acre	1,050	xx	1,750	xx	2,750	xx	4,100	xx	5,650	xx	7,500	xx	9,350	xx
	Bd. ft. vol. per acre	---	xx	500	xx	3,700	xx	11,900	xx	23,900	xx	39,000	xx	55,200	xx
60	No. trees per acre	2,800	1,081	1,145	396	662	231	445	168	340	139	269	120	224	105
	Basal area-sq. ft./acre	141	106	169	114	198	140	228	156	258	177	288	205	317	225
	Ave. diam-inches	3.0	4.2	5.1	7.3	7.4	10.5	9.7	13.0	11.8	15.3	14.0	17.7	16.1	19.8
	Cu. ft. vol. per acre	1,800	xx	2,750	xx	3,950	xx	5,850	xx	8,150	xx	10,900	xx	13,700	xx
	Bd. ft. vol. per acre	100	xx	3,700	xx	12,600	xx	27,000	xx	45,400	xx	66,400	xx	88,300	xx
80	No. trees per acre	1,300	458	634	223	393	148	286	120	225	102	185	89	162	80
	Basal area-sq. ft./acre	141	97	169	118	198	136	228	159	258	181	288	205	318	220
	Ave. diam-inches	4.5	6.2	7.0	9.8	9.6	13.0	12.1	15.6	14.5	18.0	16.9	20.5	19.0	22.5
	Cu. ft. vol. per acre	2,400	xx	3,400	xx	4,900	xx	7,100	xx	9,950	xx	13,500	xx	16,950	xx
	Bd. ft. vol. per acre	1,000	xx	8,800	xx	23,100	xx	40,200	xx	62,200	xx	88,700	xx	116,400	xx
100	No. trees per acre	744	257	400	150	266	109	199	90	162	78	139	68	123	63
	Basal area-sq. ft./acre	141	98	169	117	198	138	228	162	258	181	288	205	318	209
	Ave. diam-inches	5.9	8.4	8.8	12.0	11.7	15.2	14.5	18.1	17.1	20.6	19.5	23.5	21.8	24.7
	Cu. ft. vol. per acre	2,900	xx	3,900	xx	5,650	xx	8,100	xx	11,350	xx	15,450	xx	19,350	xx
	Bd. ft. vol. per acre	3,200	xx	14,600	xx	31,200	xx	50,300	xx	75,600	xx	107,000	xx	140,200	xx
120	No. trees per acre	512	178	281	112	196	86	152	72	125	62	---	---	---	---
	Basal area-sq. ft./acre	141	99	169	116	198	138	228	161	258	178	---	---	---	---
	Ave. diam.-inches	7.1	10.1	10.5	13.8	13.6	17.2	16.6	20.2	19.5	22.9	---	---	---	---
	Cu. ft. vol. per acre	3,300	xx	4,400	xx	6,200	xx	8,850	xx	12,400	xx	---	---	---	---
	Bd. ft. vol. per acre	6,200	xx	20,000	xx	37,300	xx	58,200	xx	86,400	xx	---	---	---	---
140	No. trees per acre	375	139	219	90	153	70	120	59	99	50	---	---	---	---
	Basal area-sq. ft./acre	141	99	169	118	198	143	228	159	258	178	---	---	---	---
	Ave. diam-inches	8.3	11.4	11.9	15.5	15.4	19.4	18.7	22.2	21.9	25.5	---	---	---	---
	Cu. ft. vol. per acre	3,600	xx	4,800	xx	6,650	xx	9,450	xx	13,250	xx	---	---	---	---
	Bd. ft. vol. per acre	9,300	xx	24,400	xx	42,500	xx	64,800	xx	95,200	xx	---	---	---	---
160	No. trees per acre	302	110	181	80	126	60	98	49	81	42	---	---	---	---
	Basal area-sq. ft./acre	141	100	169	120	198	139	228	160	258	171	---	---	---	---
	Ave. diam.-inches	9.3	12.9	13.1	16.5	17.0	20.6	20.7	24.5	24.2	27.3	---	---	---	---
	Cu. ft. vol. per acre	3,800	xx	5,100	xx	7,050	xx	10,000	xx	13,950	xx	---	---	---	---
	Bd. ft. vol. per acre	12,000	xx	28,300	xx	46,900	xx	70,600	xx	102,800	xx	---	---	---	---
180	No. trees per acre	254	101	152	69	106	51	82	42	68	36	---	---	---	---
	Basal area-sq. ft./acre	141	98	169	121	198	137	228	158	258	173	---	---	---	---
	Ave. diam.-inches	10.1	13.3	14.3	17.9	18.5	22.2	22.6	26.3	26.4	29.7	---	---	---	---
	Cu. ft. vol. per acre	4,000	xx	5,400	xx	7,450	xx	10,500	xx	14,550	xx	---	---	---	---
	Bd. ft. vol. per acre	14,400	xx	31,600	xx	50,900	xx	75,900	xx	109,600	xx	---	---	---	---
200	No. trees per acre	218	87	130	60	92	45	70	37	58	32	---	---	---	---
	Basal area-sq. ft./acre	141	96	169	120	198	135	228	157	258	166	---	---	---	---
	Ave. diam.-inches	10.9	14.2	15.4	19.1	19.9	23.5	24.4	27.9	28.6	30.8	---	---	---	---
	Cu. ft. vol. per acre	4,200	xx	5,600	xx	7,800	xx	10,950	xx	15,100	xx	---	---	---	---
	Bd. ft. vol. per acre	16,700	xx	34,600	xx	54,700	xx	80,800	xx	115,600	xx	---	---	---	---

1/Total stand information from Table 3, 4, and 5, Meyer, 1938. See text for derivation of dominant stand information.

2/Average diameter represents the diameter of a tree of average basal area.

3/Internstional rule (1/8-inch Kerf).

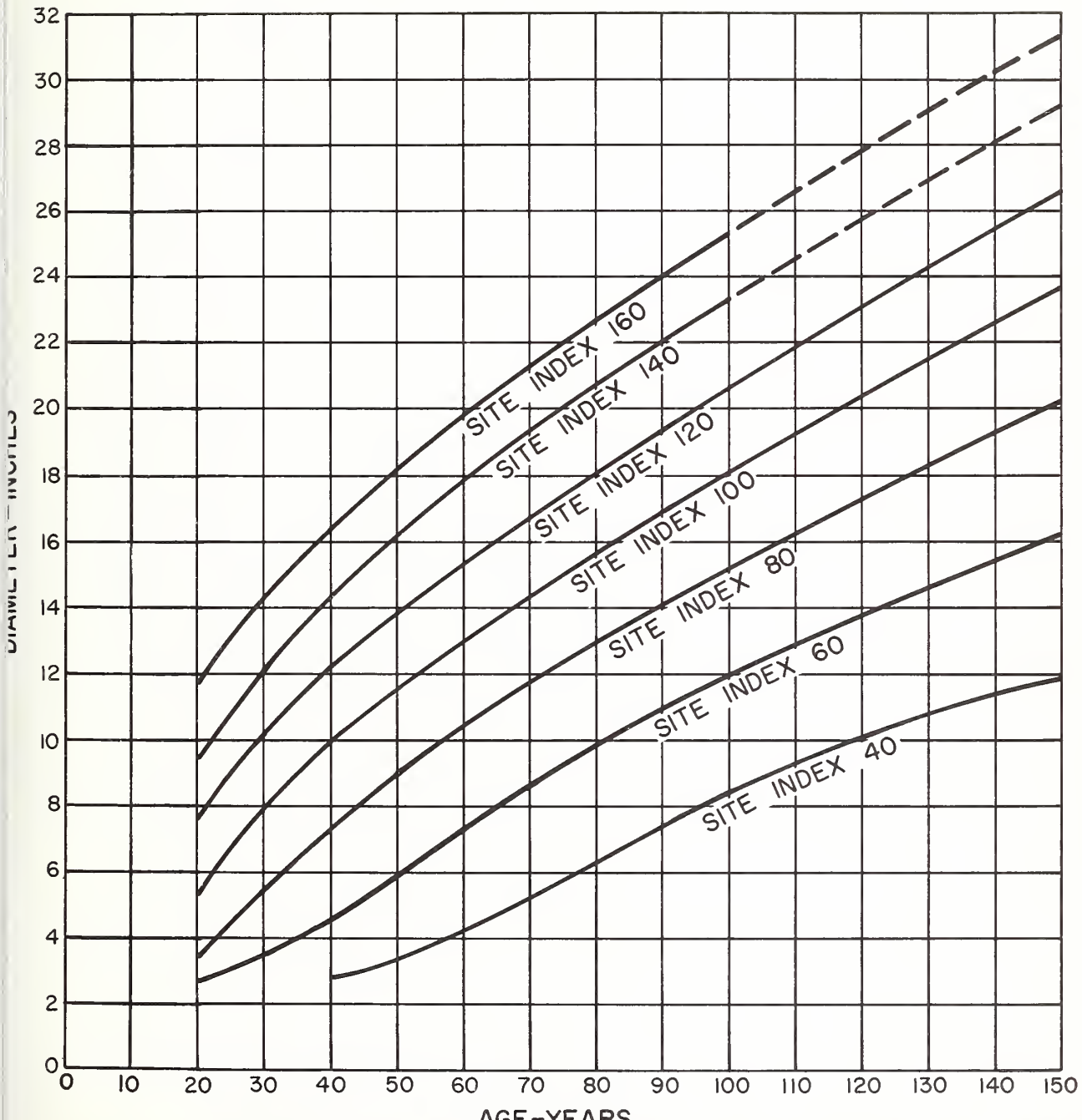

Figure 5. (Lemmon and Schumacher, 1962a). Relationship between age and diameter of tree of average basal area for the dominant and codominant portion of unthinned even-aged ponderosa pine stands by site index classes.

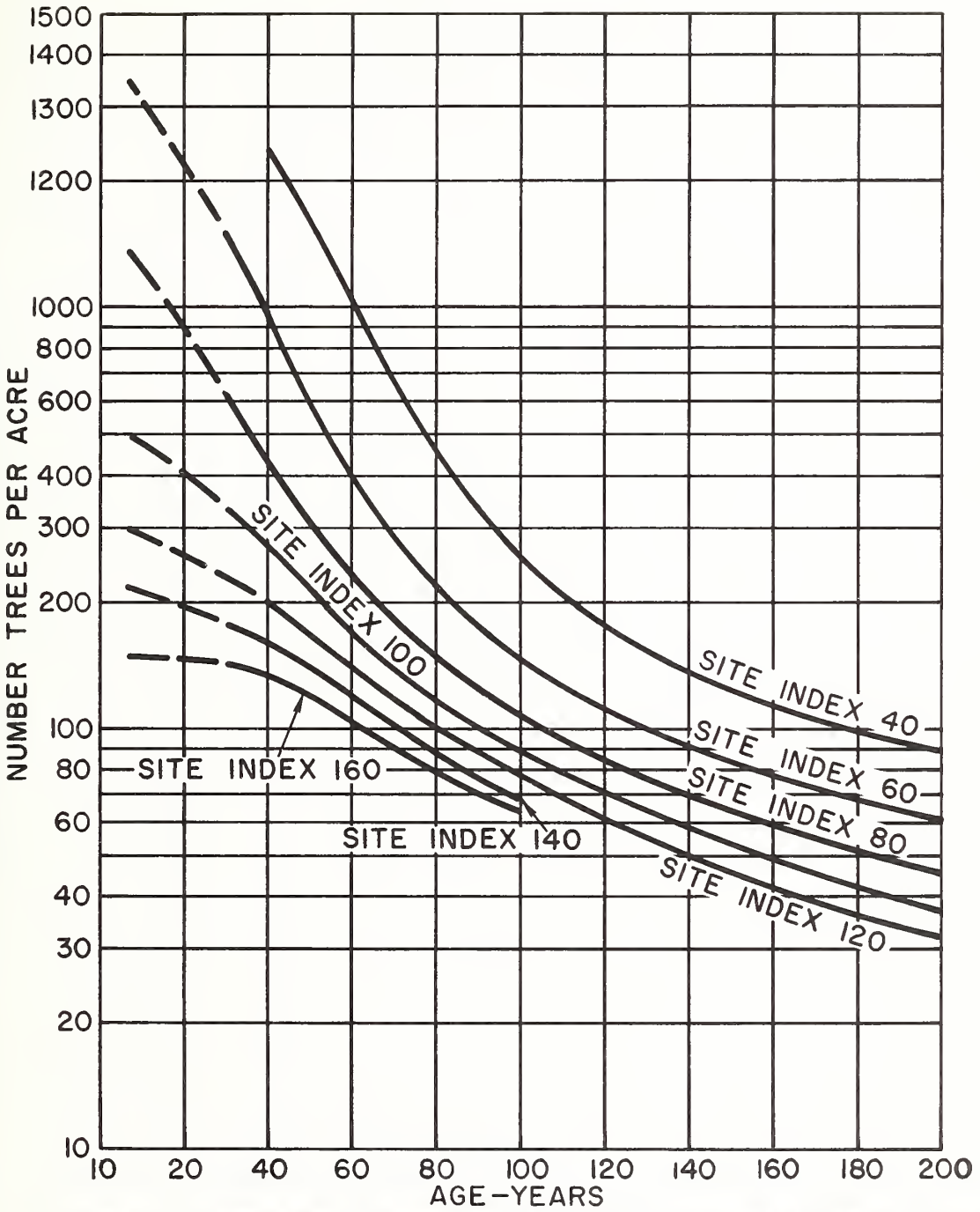

Figure 6. (Lemmon and Schumacher, 1962a). Relationship between age and number of dominant and codominant trees per acre in even-aged ponderosa pine stands.

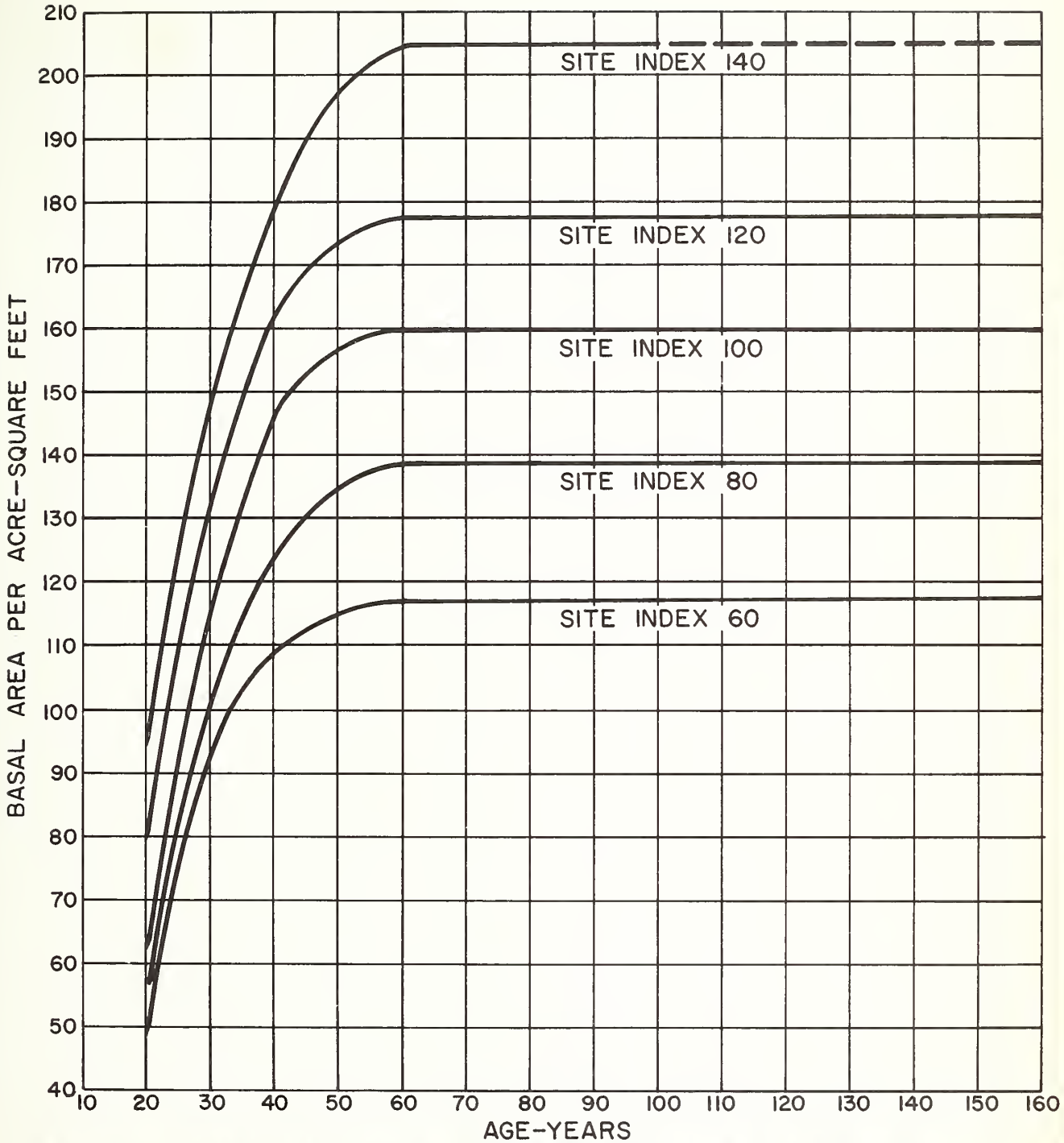

Figure 7. (Lemmon and Schumacher, 1962a) Relationship between age and basal area for the dominant and codominant portion of unthinned even-aged ponderosa pine stands by site index classes.

EXPLANATION OF TABLE 7a AND FIGURE 8 (unpublished)

Using derived values (see preceding section) for the dominant and codominant portions of normal unthinned stands, calculations were made as shown in table 7a to indicate the reduction in basal area at different ages and for different site classes when the $(D+6)^2$ spacing rule was applied. The values have been curved in Figure 8 and related on a percentage basis to that of the unthinned stand at like ages and on like sites.

TABLE 78.--Calculated reduction in basal area for different sites throughout the life of the dominant portion of unthinned, fully stocked stands of Ponderosa pine, by application of the $(D+6)^2$ spacing formula[1/]

Dominant unthinned stand				After thinning to $(D+6)^2$		
					Basal area	
Age (years)	Diameter (inches)	Average No. trees per acre	Basal area in square feet per acre	Average No. trees per acre	Square feet per acre	Percentage of the unthinned stand
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Site Index 40						
40	2.8	2,348	101	566	24	24
50	3.4	1,560	98	495	31	32
60	4.2	1,010	97	419	40	41
70	5.2	650	96	348	51	53
80	6.2	458	96	292	61	64
90	7.4	330	99	242	72	73
100	8.4	255	98	210	81	83
---	---	---	---	---	---	---
140	11.4	137	97	144	102	105
---	---	---	---	---	---	---
180	13.3	101	97	117	113	116
---	---	---	---	---	---	---
200	14.2	87	96	107	118	123
Site Index 60						
20	2.7	1,213	48	573	23	48
30	3.5	1,100	73	485	32	44
40	4.6	946	109	389	45	41
50	5.9	590	112	307	58	52
60	7.3	396	115	246	72	63
70	8.6	286	115	205	83	72
---	---	---	---	---	---	---
100	12.0	150	118	134	105	89
---	---	---	---	---	---	---
140	15.5	90	118	95	124	105
---	---	---	---	---	---	---
180	17.9	69	121	76	133	110
---	---	---	---	---	---	---
200	18.8	60	116	71	137	118
Site Index 80						
20	3.4	903	57	495	31	54
30	5.4	630	100	335	53	53
40	7.3	430	125	246	72	58
50	9.0	315	139	194	86	62
60	10.5	235	141	160	96	68
70	11.8	184	140	137	104	74
---	---	---	---	---	---	---
100	15.2	112	141	97	122	87
---	---	---	---	---	---	---
140	19.3	70	142	68	138	97
---	---	---	---	---	---	---
180	23.0	51	147	52	150	102
---	---	---	---	---	---	---
200	23.3	45	133	51	151	114
Site Index 100						
20	5.3	407	62	340	52	84
30	7.9	335	114	226	77	68
40	10.0	274	149	170	93	62
50	11.6	215	158	141	103	65
60	13.0	168	155	121	112	72
70	14.3	142	158	106	118	75
---	---	---	---	---	---	---
100	18.1	89	159	75	134	84
---	---	---	---	---	---	---
140	22.4	58	159	54	148	93
---	---	---	---	---	---	---
180	26.3	42	158	42	178	113
---	---	---	---	---	---	---
200	27.7	37	155	38	159	103
Site Index 120						
20	7.6	256	81	235	74	91
30	10.2	230	131	166	94	72
40	12.2	203	165	132	107	65
50	13.8	165	171	111	115	67
60	15.3	139	177	96	123	69
70	16.7	118	179	85	129	72
---	---	---	---	---	---	---
100	20.6	78	181	62	143	79
---	---	---	---	---	---	---
140	25.4	50	176	44	155	88
---	---	---	---	---	---	---
180	29.5	36	171	35	166	97
---	---	---	---	---	---	---
200	31.0	32	168	32	168	100
Site Index 140						
20	9.4	197	95	184	89	94
30	12.1	177	141	133	106	75
40	14.3	162	181	106	118	65
50	16.2	138	198	88	126	64
60	17.9	120	210	76	133	63
70	19.3	102	210	68	138	66
80	20.7	89	208	61	143	69
90	22.1	76	202	55	147	73
100	23.3	68	201	51	151	75
Site Index 160						
20	11.7	145	108	139	104	96
30	14.2	143	157	107	118	75
40	16.3	138	200	88	128	64
50	18.2	120	217	74	134	62
60	19.8	105	225	65	139	62
70	21.3	91	225	58	144	64
80	22.7	80	225	53	149	66
90	24.0	71	223	48	151	68
100	25.3	63	220	44	154	70

[1/] Values in numbered columns as follows: (1)--self explanatory; (2)--from table 3 and fig. 4; (3)--from table 3 and fig. 5; (4)--calculated from information in columns 2 and 3; (5)--calculated from columns 2 and the formula $43560/(D+6)^2$; (6)--calculated from columns 2 and 5; (7)--calculated from columns 4 and 6.

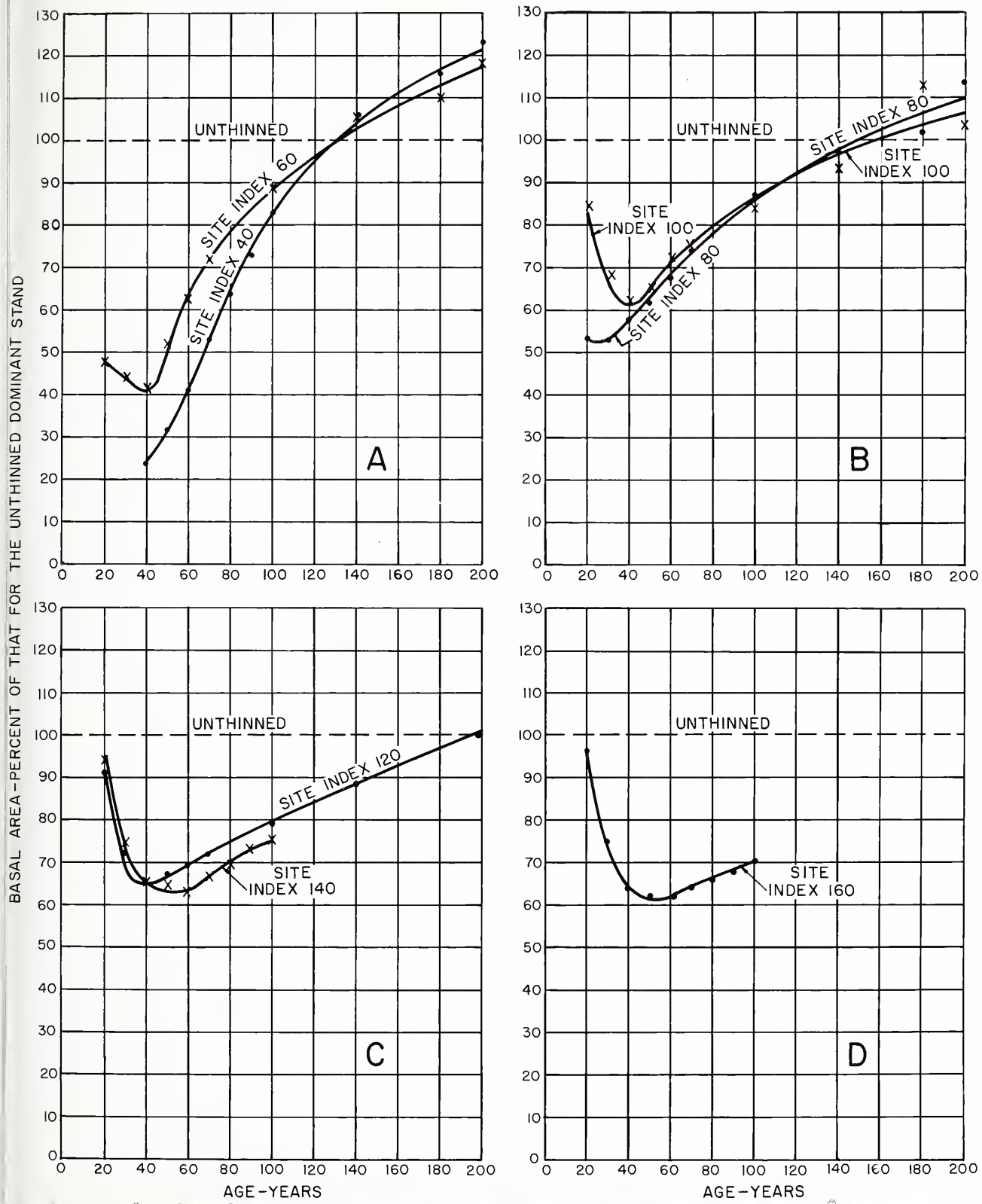

Figure 8.--Basal area of dominant stands after applying the $(D+6)^2$ spacing formula, for different site index classes, expressed as percent of that for the unthinned dominant stand. (Curved information from Table 7a.)

EXPLANATION OF TABLE 8 (unpublished)

This table shows calculations to derive the factor "F" in the biological spacing formula, as published in Forest Science 9: (1) 33-43, March, 1963.

TABLE 8.--Ratio of average space occupied and square of the average diameter of dominant and codominant trees in fully stocked unmanaged Ponderosa pine stand as influenced by age and site index 1/

Site Index 40

Age	Diameter	Average trees per acre	Average space per tree	Diameter squared	Space/squared diameter Value of F
(1) Years	(2) Inches	(3) Number	(4) Square feet	(5)	(6)
40	2.8	2,348	19	7.84	2.423
50	3.4	1,560	28	11.56	2.422
60	4.2	1,010	43	17.64	2.438
70	5.2	650	67	27.04	2.478
80	6.2	458	95	38.44	2.471
90	7.4	330	132	54.76	2.411
100	8.4	255	171	70.56	2.423
140	11.4	137	318	129.96	2.446
180	13.3	101	431	176.89	2.437
200	14.2	87	501	201.64	2.485
		Average of all F values of 50 years and above = 2.5			

Site Index 60

20	2.7	1,213	36	7.29	4.938
30	3.5	1,100	40	12.25	3.265
40	4.6	946	46	21.16	2.174
50	5.9	590	74	34.81	2.126
60	7.3	396	110	53.29	2.064
70	8.6	286	152	73.96	2.055
100	12.0	150	290	144.00	2.014
140	15.5	90	484	240.25	2.015
180	17.9	69	631	320.41	1.969
200	18.8	60	726	353.44	2.054
		Average of all F values of 50 years and above = 2.0			

Site Index 80

20	3.4	903	48	11.56	4.152
30	5.4	630	69	29.16	2.366
40	7.3	430	101	53.29	1.895
50	9.0	315	138	81.00	1.704
60	10.5	235	185	110.25	1.678
70	11.8	184	237	139.24	1.702
100	15.2	112	389	231.04	1.684
140	19.3	70	622	372.49	1.670
180	23.0	51	854	529.00	1.614
200	23.3	45	968	542.88	1.783
		Average of all F values of 50 years and above = 1.7			

Site Index 100

20	5.3	407	107	28.09	3.809
30	7.9	335	130	62.41	2.083
40	10.0	274	159	100.00	1.590
50	11.6	215	203	134.56	1.508
60	13.0	168	259	169.00	1.533
70	14.3	142	307	204.49	1.501
100	18.1	89	489	327.61	1.493
140	22.4	58	751	501.76	1.497
180	26.3	42	1,037	691.69	1.499
200	27.7	37	1,177	767.29	1.534
		Average of all F values of 50 years and above = 1.5			

Site Index 120

20	7.6	250	170	57.76	2.943
30	10.2	230	189	104.04	1.817
40	12.2	203	215	148.84	1.445
50	13.8	165	264	190.44	1.389
60	15.3	139	313	234.09	1.337
70	16.7	118	369	278.89	1.323
100	20.6	78	558	424.36	1.315
140	25.4	50	871	645.16	1.350
180	29.5	36	1,212	870.25	1.393
200	31.0	32	1,361	961.00	1.416
		Average of all F values of 50 years and above = 1.4			

Site Index 140

20	9.4	197	221	88.36	2.501
30	12.1	177	246	146.41	1.680
40	14.3	162	269	204.49	1.315
50	16.2	138	316	262.44	1.204
60	17.9	120	363	320.41	1.132
70	19.3	102	427	372.49	1.146
80	20.7	89	489	426.42	1.147
90	22.1	76	573	488.41	1.173
100	23.3	68	641	542.89	1.181
		Average of all F values of 50 years and above = 1.2			

Site Index 160

20	11.7	145	300	136.89	2.192
30	14.2	143	305	201.64	1.513
40	16.3	138	316	265.69	1.189
50	18.2	120	363	331.24	1.096
60	19.8	105	415	392.04	1.059
70	21.3	91	479	453.69	1.055
80	22.7	80	545	515.29	1.058
90	24.0	71	614	576.00	1.066
100	25.3	63	691	640.09	1.079
		Average of all F values of 50 years and above = 1.1			

1/ Values in numbered columns obtained as follows: (1, 2, and 3) - from Table 7 and figures 5 and 6 (Lemon and Schumacher, 1962a); (4) - computed with the formula 43560/(number of trees per acre in column 3); (5) - self explanatory; (6) - values in column 4 divided by those in column 5.

EXPLANATION OF TABLES 9 AND 10, AND FIGURE 9 (unpublished)

Using derived values for the dominant and codominant portions of normal unthinned stands (see preceding section) calculations were made as shown in Table 9 to indicate the reduction in basal area at different ages and for different site classes when the biological spacing formula, $S = (D+X)^2F$, was applied. Several values for the constant "X" are used. The basal area values were expressed as percent of those for the dominant portion of unthinned stands of like ages and site index. Table 10 represents a summary of some of the information shown in Table 9. Average values from Table 9 were plotted and curved for different sites and different degrees of spacing in Figure 9 to show the reduction in basal area by applying the biological spacing formula.

TABLE 9.--Calculated reduction in basal area for different sites throughout the life of the dominant portion of unthinned, fully stocked stands of Ponderosa pine by application of the biological spacing formula, $(D+X)^2F$, using different values of X

Site Index 40

Dominant unthinned stand		Number of trees per acre and basal area for different values of X											
		$(D+1)^2F$			$(D+2)^2F$			$(D+3)^2F$			$(D+4)^2F$		
Age	Basal area [1]	Number of trees	Basal area Sq. ft.	Basal area Percent unthinned [2]	Number of trees	Basal area Sq. ft.	Basal area Percent unthinned [2]	Number of trees	Basal area Sq. ft.	Basal area Percent unthinned [2]	Number of trees	Basal area Sq. ft.	Basal area Percent unthinned [2]
40	101	1,245	53	52	778	33	33	531	23	23	389	17	17
50	98	927	58	59	614	39	40	440	28	29	328	21	21
60	97	660	63	65	463	45	46	346	33	34	266	26	27
70	96	459	68	71	340	50	52	261	38	40	207	31	32
80	96	340	71	74	262	55	57	208	44	46	169	35	36
90	99	256	76	77	205	61	62	167	50	51	139	42	43
100	98	204	78	80	166	64	65	138	53	54	117	45	46
140	97	116	82	85	99	70	72	86	61	63	75	53	55
180	97	87	84	87	76	73	75	67	65	67	60	58	60
200	96	76	84	88	67	74	77	59	65	68	53	58	60
					Site Index 60								
20	48	641	26	54	400	16	33	272	11	23	196	8	17
30	73	660	44	60	440	29	40	316	21	29	237	16	22
40	109	641	74	68	459	53	49	346	40	37	271	31	28
50	112	431	82	73	328	62	55	259	49	44	209	40	36
60	115	307	89	77	243	71	62	199	58	50	165	48	42
70	115	231	93	81	189	76	66	157	63	55	134	54	47
100	118	128	101	86	110	86	73	96	75	64	84	66	56
140	118	79	104	88	71	93	80	63	83	70	57	75	64
180	121	62	108	89	56	98	81	51	89	74	46	80	66
200	116	54	104	90	49	94	81	45	87	75	41	79	68

Site Index 80

20	57	545	34	60	360	23	40	256	16	28	192	12	21
30	100	449	71	71	335	53	53	260	41	41	208	33	33
40	125	338	98	78	266	77	62	217	63	50	180	52	42
50	139	256	113	81	211	93	67	178	79	57	151	67	48
60	141	196	118	84	166	100	71	142	85	60	123	74	52
70	140	156	118	84	134	102	73	117	89	64	102	77	55
80	141	99	125	89	87	110	78	78	98	70	70	88	62
100	142	63	128	90	57	116	82	52	106	75	48	98	69
120	143	47	136	93	43	124	84	40	115	78	37	107	73
140	147	41	121	91	38	113	85	35	104	78	33	98	74
160	133												

Site Index 100

20	62	288	44	71	215	33	53	166	25	40	132	20	32
30	114	264	90	79	214	73	64	176	60	53	148	50	44
40	149	227	124	83	190	104	70	163	89	60	140	76	51
50	158	182	134	85	156	114	72	136	100	63	119	87	55
60	159	145	132	85	126	115	74	111	101	65	98	89	57
70	158	124	138	87	109	122	77	97	108	68	87	97	61
80	159	89	143	90	72	129	81	66	118	74	60	107	67
100	159	52	145	91	49	134	84	45	123	77	42	115	72
120	159	39	147	93	36	136	86	34	128	81	32	121	77
140	156	34	148	92	32	134	86	30	126	81	28	117	75
160	155												

Site Index 120

20	61	200	63	78	161	51	63	132	42	52	110	35	43
30	133	231	108	82	161	91	69	137	78	60	119	68	52
40	165	173	140	85	150	122	74	130	106	64	115	93	56
50	174	143	149	87	126	131	77	111	115	67	99	103	60
60	177	123	157	89	109	139	79	97	123	69	87	111	63
70	179	105	160	89	94	143	80	85	129	72	77	117	65
80	181	71	164	91	65	150	83	60	139	77	55	127	70
100	178	46	162	92	43	151	86	40	141	80	37	130	74
120	171	34	161	94	32	152	89	30	142	83	28	133	78
140	168	30	157	93	28	147	88	27	142	85	25	131	78
160													
200													

Site Index 140

20	35	162	78	82	138	38	50	115	54	57	97	47	49
30	141	151	121	86	131	104	74	114	91	65	100	80	57
40	181	141	157	87	125	119	77	111	124	69	99	110	61
50	198	122	175	86	105	136	79	98	140	71	89	127	64
60	210	108	185	88	97	166	79	88	150	71	80	137	65
70	210	92	187	89	86	171	82	77	156	74	70	142	68
80	208	81	189	91	74	173	83	68	159	76	62	145	70
90	204	70	186	92	64	170	84	59	157	78	55	147	73
100	201	61	181	90	57	169	84	53	157	78	49	145	77

Site Index 160

20	106	123	92	95	106	79	73	92	69	64	81	60	59
30	157	124	136	87	110	120	77	97	107	68	87	96	63
40	200	122	177	89	109	139	79	98	142	71	89	129	66
50	217	108	195	90	97	172	81	88	154	73	81	146	67
60	225	95	203	90	87	186	83	79	169	75	73	156	68
70	225	83	205	91	76	190	84	70	173	77	65	161	70
80	225	74	208	92	68	193	85	62	174	77	58	163	71
90	223	65	204	91	60	188	84	56	176	79	52	163	73
100	220	58	202	92	54	189	86	50	175	80	47	164	75

1/ Calculated for the unthinned dominant stand on basis of diameters and numbers of trees per acre at different ages (in table 7).

2/ These values represent the basal area of stands after thinning, expressed as a percentage of that for the dominant portion of unthinned stands.

TABLE 10.--Summary of basal area, expressed as percentage of that for unthinned dominant stand, by age, site index, and different degrees of thinning with the biological spacing rule (summarized from table 9)

Age	Site index	Basal area expressed as percentage of that for dominant unthinned stand			
		$(D+1)^2F$	$(D+2)^2F$	$(D+3)^2F$	$(D+4)^2F$
20	60	54	33	23	17
	80	60	40	28	21
	100	71	53	40	32
	120	78	63	52	43
	140	82	68	57	49
	160	85	72	64	56
	Average	72	55	44	36
40	60	68	49	37	28
	80	77	62	50	42
	100	82	69	59	51
	120	85	74	64	56
	140	87	77	68	61
	160	89	79	71	65
	Average	81	68	58	51
60	60	77	61	50	42
	80	84	71	61	52
	100	86	75	66	59
	120	89	79	70	63
	140	89	81	73	66
	160	91	83	75	70
	Average	86	75	66	59
80	60	83	69	59	51
	80	86	75	66	58
	100	89	78	71	64
	120	90	81	73	67
	140	90	83	75	70
	160	91	84	78	72
	Average	88	78	70	64
100	60	86	74	65	57
	80	88	78	70	63
	100	90	81	74	67
	120	91	83	76	70
	140	91	84	78	72
	160	92	85	79	74
	Average	90	81	74	67
120	60	87	78	69	61
	80	90	80	73	67
	100	91	83	76	70
	120	91	85	78	72
	140	--	--	--	--
	160	--	--	--	--
	Average	90	82	74	68
140	60	88	80	71	64
	80	91	82	75	69
	100	92	84	78	72
	120	92	86	80	74
	140	--	--	--	--
	160	--	--	--	--
	Average	91	83	76	70
160	60	89	81	73	66
	80	92	83	77	72
	100	92	85	79	74
	120	93	87	81	75
	140	--	--	--	--
	160	--	--	--	--
	Average	92	84	78	72
180	60	90	81	74	67
	80	92	84	78	73
	100	93	86	80	75
	120	93	88	83	77
	140	--	--	--	--
	160	--	--	--	--
	Average	92	85	79	73
200	60	90	81	74	67
	80	92	85	79	74
	100	93	86	81	76
	120	93	87	84	78
	140	--	--	--	--
	160	--	--	--	--
	Average	92	85	80	74

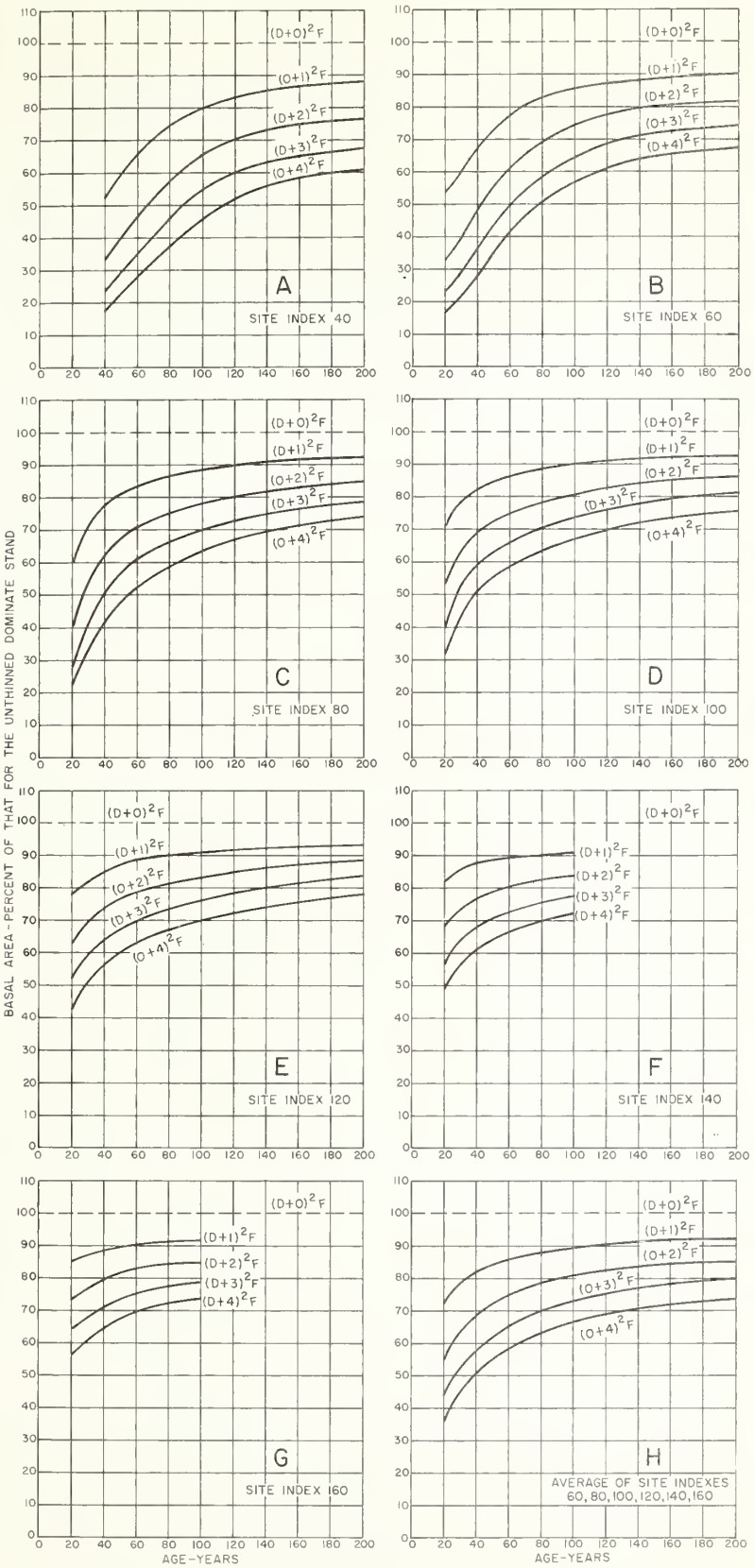

Figure 9. Basal area of dominant stands of ponderosa pine after applying the biological spacing formula $(D+X)^2F$, for different site indexes and for different values of the factor X, expressed as percent of that for the unthinned dominant stand. (Plotted and curved from information in Table 10).

EXPLANATION OF TABLE 11 (unpublished)

This is a summary of the tabulations and computations referred to in Forest Science 9: (1) 33-43, March, 1963, to determine the correct thinning interval lengths when applying the biological spacing formula with different degrees of spacing. Only the average values were plotted and curved in the article cited.

TABLE 11.--Average of all basal area values at the ends of each growth interval beyond 50 years of age, expressed as percentage of the average basal area of the dominant portion of unthinned stands of comparable age

Length of thinning interval	Site index class	Degree of spacing in thinned stands[1/]				
		$(D+0)^2F$	$(D+1)^2F$	$(D+2)^2F$	$(D+3)^2F$	$(D+4)^2F$
Years		Percent	Percent	Percent	Percent	Percent
5----------	60	109.0	93.0	82.0	73.0	65.0
	100	106.0	98.0	91.0	85.0	80.0
	140	101.0	96.0	90.0	86.0	75.0
Average all sites----------		105.3	95.6	87.7	81.3	73.3
10----------	60	118.0	101.0	88.0	79.0	70.0
	100	112.0	103.0	96.0	89.0	84.0
	140	105.0	99.0	94.0	89.0	85.0
Average all sites----------		111.7	101.0	92.7	85.7	79.7
15----------	60	128.0	109.0	95.0	89.0	76.0
	100	119.0	113.0	101.0	94.0	89.0
	140	110.0	103.0	98.0	93.0	88.0
Average all sites----------		119.0	108.3	98.0	90.3	84.3
20----------	60	131.0	113.0	99.0	89.0	80.0
	100	120.0	111.0	103.0	96.0	90.0
	140	112.0	105.0	100.0	95.0	90.0
Average all sites----------		121.0	110.0	100.7	93.3	86.7

[1/] Each value in these columns represents the average for all thinning intervals beyond 50 years of age. Although not from identical calculations, the variation by age existing within each average is of about the same magnitude as shown for the different sites in fig. 14.

EXPLANATION OF TABLES 12, 13, 14, 15, and 16
(unpublished except for Table 13)

These are the complete sets of calculated growth and yield information for site classes 60, 80, 100, 120, and 140 using the biological spacing formula with uniform thinning interval lengths of 5, 10, 15, and 20 years. Table 13 for site index 80 was published as an example in Forest Science 9: (1) 33-43, March, 1963.

Source or derivation, and explanation of columns 1 through 14 are:

Column No.	Item and explanation
1	Self explanatory.
2	Thinning regimes were started at 30 years of age using stand information from table 7 or curved values from figures 5,6, and 7. These are shown on the first line of each schedule opposite the word "start." Subsequent entries in this column show the beginning and ending ages of each thinning interval.
3	The first diameter value is from Table 7 (read from the curved values in Fig. 5). The second value is obtained from the first entry by adding 0.5 inch. It is assumed that the first thinning results in a larger average diameter of residual dominant and codominant stems than the average diameter of that portion of the stand prior to thinning. Subsequent entries in column 3 are obtained from column 4 of the line immediately above.
4	Values obtained by a 5-year projection method, i.e., past 5-year radial growth under stated conditions of age, diameter, and basal area density fixed by thinning rules was calculated according to Equation III, short form (Lemmon & Schumacher, 1962a) and added to the beginning diameter.
5	Starting values from Table 7 and Figure 6. Subsequent values derived by dividing 43560 (the number of square feet per acre) by the space provided for the average diameter tree with the thinning rule used. For instance,

S (space) = $(D+X)^2F$ when the biological spacing rule is used. Where thinning intervals were longer than 5 years, new conditions were set up for the equation and diameter increase calculated and projected for a second 5-year period or fraction thereof. In each recalculation the number of trees per acre was fixed at the start of each interval and remained the same throughout the period, assuming no loss from mortality. In the case of the biological spacing rule, the value F for ages prior to 50 years was read from (Fig. 1, Lemmon and Schumacher, 1963).

6 — Calculated from clumns 3 and 5.

7 — Calculated from columns 4 and 5.

8 — From table 7 and figure 7 at the ending age of each thinning interval.

9 and 10 — Based on values in columns 4 and 5 and height information from site index curves. Cubic feet values obtained from the V_1 equation (see explanation of volume equations), and board feet values, International rule, 1/8-inch kerf, obtained from the V_2 equation equation when electronic computations were used. For desk calculations these values were read from curves plotted from original data in tables 32 and 33 (Meyer, 1938). No cubic feet volume is assumed to exist for trees less than 4 inches in diameter. No board feet volume is assumed to exist for trees less than 8 inches in diameter.

11 and 12 — These columns give volumes removed at the beginning of each thinning interval. Calculations were made in the same way as explained above for columns 9 and 10. Diameters used in this case were obtained from column 3 (starting diameters) and the number of trees removed by subtracting the value in column 5 from the preceding value in column 5. Site index curves were used to determine height.

13 — Sum of values in column 9 and 11 plus all preceding values in column 11.

14 — Sum of values in columns 10 and 12 plus all preceding values in column 12.

TABLE 12.--Calculated growth and yield for hypothetical Ponderosa pine stands of site index 60 for four thinning regimes that give theoretical optimum production [1/]

Site index 60--5 year thinning interval--$(D+0.5)^2F$ spacing

Thinning cycle		Diameters		Trees per acre	Basal area--square feet per acre			Residual volume per acre		Volume removed per acre		Volume--residual plus cumulative removed per acre	
					Thinned stand								
No.	Age	Start	End		Start	End	Unthinned dominant stand	Cu. ft.	Bd. ft. ⅄ 10	Cu. ft.	Bd. ft. ⅄ 10	Cu. ft.	Bd. ft. ⅄ 10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Years	in.	in.	No.									
Start	30	3.5	----	1,100	---	---	93	-----	-----	-----	---	-----	-----
1	30-35	4.0	4.6	702	61	81	104	642	-----	-----	---	642	-----
2	35-40	4.6	5.1	660	76	94	109	1,122	-----	50	---	1,172	-----
3	40-45	5.1	5.6	614	87	105	112	1,351	-----	78	---	1,479	-----
4	45-50	5.6	6.1	531	91	108	115	1,487	-----	183	---	1,796	-----
5	50-55	6.1	6.5	489	99	113	116	1,666	-----	118	---	2,092	-----
6	55-60	6.5	6.9	436	100	113	117	1,788	-----	180	---	2,397	-----
7	60-65	6.9	7.3	389	101	113	118	1,867	-----	193	---	2,669	-----
8	65-70	7.3	7.7	348	101	113	118	1,949	-----	197	---	2,948	-----
9	70-75	7.7	8.1	316	102	113	118	2,022	348	179	---	3,200	348
10	75-80	8.1	8.5	287	103	113	118	2,124	459	156	32	3,468	491
11	80-85	8.5	8.9	262	103	113	118	2,201	576	165	40	3,750	648
12	85-90	8.9	9.3	241	104	114	118	2,290	675	176	46	4,015	793
13	90-95	9.3	9.6	221	104	111	118	2,321	796	190	56	4,236	970
14	95-100	9.6	9.9	208	105	111	118	2,454	894	137	47	4,506	1,115
15	100-105	9.9	10.2	196	105	111	118	2,548	1,019	142	52	4,742	1,292
16	105-110	10.2	10.5	185	105	111	118	2,646	1,129	143	57	4,903	1,459
17	110-115	10.5	10.8	176	106	112	118	2,781	1,232	129	50	5,247	1,612
18	115-120	10.8	11.1	166	106	112	118	2,855	1,311	158	70	5,479	1,761
19	120-125	11.1	11.4	158	106	112	118	2,923	1,406	138	63	5,685	1,919
20	125-130	11.4	11.7	150	106	112	118	3,000	1,470	148	71	5,910	2,054
21	130-135	11.7	12.0	143	107	112	118	3,103	1,544	140	69	6,153	2,197
22	135-140	12.0	12.3	136	107	112	118	3,169	1,618	152	76	6,371	2,347
23	140-145	12.3	12.6	130	107	113	118	3,250	1,690	140	71	6,592	2,490
24	145-150	12.6	12.9	124	107	113	118	3,348	1,761	150	78	6,840	2,639
										3,492	870		

Site index 60--10 year thinning interval--$(D+1.1)^2F$ spacing

Start	30	3.5	----	1,100	---	---	93	-----	-----	-----	---	-----	-----
1	30-40	4.0	5.2	545	48	80	109	927	-----	-----	---	927	-----
2	40-50	5.2	6.2	489	72	103	115	1,369	-----	95	---	1,464	-----
3	50-60	6.2	7.0	400	84	107	117	1,640	-----	249	---	1,904	-----
4	60-70	7.0	7.9	323	86	110	118	1,809	-----	316	---	2,469	-----
5	70-80	7.9	8.6	262	89	106	118	1,939	419	242	---	2,641	419
6	80-90	8.6	9.4	226	91	109	118	2,147	633	266	58	3,315	691
7	90-100	9.4	10.2	193	93	110	118	2,277	830	314	92	3,759	980
8	100-110	10.2	10.8	166	94	106	118	2,374	1,013	319	116	4,175	1,279
9	110-120	10.8	11.5	150	95	108	118	2,580	1,185	229	98	4,610	1,549
10	120-130	11.5	12.1	134	97	107	118	2,680	1,313	275	126	4,985	1,803
11	130-140	12.1	12.7	122	97	107	118	2,867	1,452	240	118	5,412	2,060
12	140-150	12.7	13.3	112	99	108	118	3,024	1,590	235	119	5,804	2,317
										2,760	727		

Site index 60--15 year thinning interval--$(D+1.8)^2F$ spacing

Start	30	3.5	----	1,100	---	---	93	-----	-----	-----	---	-----	-----
1	30-45	4.0	5.7	419	37	74	112	922	-----	-----	---	922	-----
2	45-60	5.7	7.1	351	62	96	117	1,439	-----	150	---	1,589	-----
3	60-75	7.1	8.3	269	74	101	118	1,722	296	336	---	2,208	296
4	75-90	8.3	9.6	206	78	105	118	1,976	582	390	67	2,652	649
5	90-105	9.6	10.7	164	82	102	118	2,132	853	418	123	3,426	1,043
6	105-120	10.7	11.8	136	85	103	118	2,339	1,074	364	146	3,997	1,410
7	120-135	11.8	12.8	115	87	103	118	2,507	1,242	361	166	4,526	1,744
8	135-150	12.8	13.7	100	89	102	118	2,700	1,420	327	162	5,046	2,084
										2,348	664		

Site index 60--20 year thinning interval--$(D+2.2)^2F$ spacing

Start	30	3.5	----	1,100	---	---	93	-----	-----	-----	---	-----	-----
1	30-50	4.0	6.2	369	32	77	115	1,033	-----	-----	---	1,033	-----
2	50-70	6.2	7.9	300	63	102	118	1,680	-----	193	---	1,873	-----
3	70-90	7.9	9.6	208	71	105	118	1,976	562	515	---	2,684	562
4	90-110	9.6	11.2	153	77	105	118	2,188	933	523	154	3,419	1,087
5	110-130	11.2	12.7	118	81	104	118	2,360	1,156	501	214	4,092	1,524
6	130-150	12.7	14.0	96	84	103	118	2,592	1,363	440	216	4,704	1,947
										2,172	584		

1/ See appendix for source or derivation and explanation of columns 1 through 14.

TABLE 13--Calculated growth and yield for hypothetical Ponderosa pine stands of site index 80 for four thinning regimes that give theoretical optimum production

Site index 80--5 year thinning interval--$(D+0.5)^2F$ spacing

Thinning cycle		Diameters		Trees per acre	Basal area--square feet per acre			Residual volume per acre		Volume removed per acre		Volume--residual plus cumulative removed per acre	
					Thinned stand		Unthinned dominant stand						
No.	Age	Start	End		Start	End		Cu. ft.	Bd. ft. in tens	Cu. ft.	Bd. ft. in tens	Cu. ft.	Bd. ft. in tens
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Years	in.	in.	No.									
Start	30	5.4	----	635	---	---	102	1,270	-----	-----	-----	1,270	-----
1	30-35	5.9	7.0	400	76	107	115	1,400	-----	470	-----	1,870	-----
2	35-40	7.0	8.0	348	93	121	124	1,801	348	182	-----	2,453	348
3	40-45	8.0	8.9	307	107	133	131	2,180	522	213	41	3,045	563
4	45-50	8.9	9.7	271	117	139	135	2,520	786	256	61	3,641	888
5	50-55	9.7	10.4	239	123	141	137	2,772	1,052	298	93	4,191	1,247
6	55-60	10.4	11.1	209	123	140	139	2,968	1,233	348	132	4,735	1,560
7	60-65	11.1	11.7	184	124	137	139	3,091	1,398	355	148	5,213	1,873
8	65-70	11.7	12.2	165	123	134	139	3,218	1,551	319	144	5,659	2,170
9	70-75	12.2	12.7	153	124	135	139	3,443	1,744	234	113	6,118	2,476
10	75-80	12.7	13.3	141	124	136	139	3,610	1,875	270	137	6,555	2,744
11	80-85	13.3	13.7	129	124	132	139	3,715	2,000	307	160	6,967	3,029
12	85-90	13.7	14.2	122	125	134	139	3,904	2,172	202	109	7,358	3,310
13	90-95	14.2	14.7	115	126	136	139	4,060	2,335	224	125	7,738	3,598
14	95-100	14.7	15.2	107	126	135	139	4,141	2,461	282	162	8,101	3,886
15	100-105	15.2	15.7	100	126	134	139	4,200	2,570	271	161	8,431	4,156
16	105-110	15.7	16.1	94	126	133	139	4,296	2,679	252	154	8,779	4,419
17	110-115	16.1	16.5	90	127	134	139	4,410	2,826	183	114	9,076	4,680
18	115-120	16.5	16.9	86	128	134	139	4,558	2,950	196	126	9,420	4,930
19	120-125	16.9	17.3	81	126	132	139	4,617	3,021	265	172	9,744	5,173
20	125-130	17.3	17.7	77	126	132	139	4,697	3,142	228	149	10,052	5,443
21	130-135	17.7	18.1	74	126	132	139	4,847	3,241	183	122	10,385	5,664
22	135-140	18.1	18.6	72	129	136	139	4,968	3,384	131	88	10,637	5,895
23	140-145	18.6	19.0	68	128	134	139	5,032	3,400	276	188	10,977	6,099
24	145-150	19.0	19.4	64	127	131	139	5,056	3,424	296	200	11,297	6,323
										6,241	2,899		

Site index 80--10 year thinning interval--$(D+1.1)^2F$ spacing

Start	30	5.4	----	635	---	---	102	1,270	-----	-----	-----	1,270	-----
1	30-40	5.9	8.1	335	64	120	124	1,742	335	600	-----	2,342	335
2	40-50	8.1	9.8	262	94	137	135	2,437	760	380	73	3,417	833
3	50-60	9.8	11.1	209	109	140	139	2,968	1,233	493	154	4,441	1,460
4	60-70	11.1	12.3	168	113	139	139	3,276	1,579	582	242	5,331	2,048
5	70-80	12.3	13.3	139	115	134	139	3,558	1,849	566	273	6,179	2,591
6	80-90	13.3	14.3	120	116	134	139	3,840	2,136	486	253	6,947	3,131
7	90-100	14.3	15.3	105	117	134	139	4,064	2,415	480	267	7,651	3,677
8	100-110	15.3	16.1	92	117	130	139	4,204	2,622	503	299	8,294	4,183
9	110-120	16.1	16.9	84	119	131	139	4,452	2,881	366	228	8,908	4,670
10	120-130	16.9	17.7	77	120	132	139	4,697	3,142	371	240	9,524	5,171
11	130-140	17.7	18.5	70	120	131	139	4,900	3,290	427	286	10,154	5,605
12	140-150	18.5	19.3	65	121	132	139	5,135	3,478	350	235	10,739	6,028
										5,604	2,550		

Site index 80--15 year thinning interval--$(D+1.8)^2F$ spacing

Start	30	5.4	----	635	---	---	102	1,270	-----	-----	-----	1,270	-----
1	30-45	5.9	9.0	277	52	122	131	1,967	471	716	-----	2,683	471
2	45-60	9.0	11.3	205	91	143	139	2,911	1,210	511	122	4,138	1,332
3	60-75	11.3	13.0	145	101	134	139	3,263	1,653	852	354	5,342	2,129
4	75-90	13.0	14.6	114	105	133	139	3,648	2,029	698	353	6,425	2,858
5	90-105	14.6	16.1	92	107	130	139	3,864	2,364	704	392	7,345	3,585
6	105-120	16.1	17.4	78	110	129	139	4,134	2,675	588	360	8,203	4,256
7	120-135	17.4	18.7	68	112	130	139	4,454	2,978	530	343	9,053	4,902
8	135-150	18.7	19.9	59	113	127	139	4,661	3,157	590	394	9,850	5,475
										5,189	2,318		

Site index 80--20 year thinning interval--$(D+2.2)^2F$ spacing

Start	30	5.4	----	635	---	---	102	1,270	-----	-----	-----	1,270	-----
1	30-50	5.9	9.9	250	47	134	135	2,325	725	770	-----	3,095	725
2	50-70	9.9	12.6	170	91	147	139	3,315	1,598	744	232	4,829	1,830
3	70-90	12.6	14.8	114	99	136	139	3,648	2,029	1,092	526	6,254	2,787
4	90-110	14.8	16.6	86	103	129	139	3,930	2,451	896	498	7,432	3,707
5	110-130	16.6	18.4	70	105	129	139	4,270	2,856	731	456	8,503	4,568
6	130-150	18.4	20.0	59	109	129	139	4,661	3,157	671	449	9,565	5,318
										4,904	2,161		

TABLE 14.--Calculated growth and yield for hypothetical Ponderosa pine stands of site index 100 for four thinning regimes that give theoretical optimum production [1/]

Site index 100--5 year thinning interval--$(D+0.5)^2F$

Thinning interval		Diameters		Trees per acre	Basal area--square feet per acre			Residual volume per acre		Volume removed per acre		Volume--residual plus cumulative removed per acre	
					Thinned stand								
No.	Age	Start	End		Start	End	Unthinned dominant stand	Cu. ft.	Bd. ft. x 10	Cu. ft.	Bd. ft. x 10	Cu. ft.	Bd. ft. x 10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Years	in.	in.	No.									
Start	30	7.9	----	335	---	---	116	1,742	-----	-----	-----	1,742	-----
1	30-35	8.4	10.1	250	96	139	133	2,400	775	442	-----	2,842	775
2	35-40	10.1	11.7	228	127	170	146	3,260	1,414	211	68	3,913	1,482
3	40-45	11.7	12.7	186	139	164	153	3,590	1,730	601	260	4,844	2,058
4	45-50	12.7	13.7	164	144	168	157	4,018	2,083	425	205	5,697	2,616
5	50-55	13.7	14.6	144	147	167	159	4,464	2,347	490	254	6,633	3,134
6	55-60	14.6	15.3	127	148	162	160	4,572	2,578	527	277	7,268	3,642
7	60-65	15.3	16.0	116	148	162	160	4,872	2,819	396	223	7,964	4,106
8	65-70	16.0	16.7	107	149	163	160	5,115	3,082	378	219	8,585	4,588
9	70-75	16.7	17.4	98	149	162	160	5,272	3,254	430	259	9,172	5,019
10	75-80	17.4	18.0	91	150	161	160	5,369	3,458	377	232	9,646	5,455
11	80-85	18.0	18.6	85	150	160	160	5,551	3,638	354	228	10,182	5,863
12	85-90	18.6	19.2	80	151	161	160	5,760	3,824	327	214	10,718	6,263
13	90-95	19.2	19.7	75	151	159	160	5,850	3,960	360	239	11,168	6,638
14	95-100	19.7	20.2	71	150	158	160	6,035	4,118	312	211	11,665	7,007
15	100-105	20.2	20.7	68	151	159	160	6,256	4,318	255	174	12,141	7,381
16	105-110	20.7	21.2	65	152	159	160	6,370	4,485	276	191	12,531	7,739
17	110-115	21.2	21.6	62	152	158	160	6,510	4,619	294	207	12,965	8,080
18	115-120	21.6	22.1	59	150	157	160	6,667	4,720	315	224	13,437	8,405
19	120-125	22.1	22.5	57	152	157	160	6,840	4,902	226	160	13,836	8,747
20	125-130	22.5	22.9	55	152	157	160	6,985	5,033	240	172	14,221	9,050
21	130-135	22.9	23.4	53	152	158	160	7,049	5,141	254	183	14,539	9,341
22	135-140	23.4	23.8	51	152	158	160	7,140	5,202	266	194	14,896	9,596
23	140-145	23.8	24.2	49	151	157	160	7,252	5,292	280	204	15,288	9,890
24	145-150	24.2	24.6	48	153	158	160	7,440	5,424	148	108	15,624	10,130
										8,184	4,706		

Site index 100--10 year thinning interval--$(D+1.1)^2F$ spacing

Start	30	7.9	---	335	---	---	116	1,742	-----	---	---	1,742	-----
1	30-40	8.4	11.7	219	84	164	146	3,132	1,358	603	---	3,735	1,358
2	40-50	11.7	13.9	169	126	178	157	4,141	2,146	715	310	5,459	2,456
3	50-60	13.9	15.7	129	136	173	160	4,644	2,619	980	508	6,942	3,437
4	60-70	15.7	17.1	103	138	164	160	4,923	2,966	936	528	8,157	4,312
5	70-80	17.1	18.3	88	140	161	160	5,192	3,344	717	432	9,143	5,122
6	80-90	18.3	19.4	77	141	158	160	5,544	3,681	649	418	10,144	5,877
7	90-100	19.4	20.5	69	142	158	160	5,865	4,002	576	382	11,041	6,580
8	100-110	20.5	21.5	62	142	156	160	6,076	4,278	595	406	11,847	7,262
9	110-120	21.5	22.4	57	144	156	160	6,441	4,560	490	345	12,702	7,889
10	120-130	22.4	23.3	53	145	157	160	6,731	4,850	452	320	13,444	8,499
11	130-140	23.3	24.2	49	145	157	160	6,860	4,998	508	366	14,081	9,013
12	140-150	24.2	25.0	45	144	153	160	6,975	5,085	560	408	14,756	9,508
										7,781	4,423		

Site index 100--15 year thinning interval--$(D+1.8)^2F$ spacing

Start	30	7.9	---	335	---	---	116	1,742	-----	-----	---	1,742	-----
1	30-45	8.4	12.6	190	73	165	153	3,667	1,767	754	---	4,421	1,767
2	45-60	12.6	15.4	138	119	179	160	4,968	2,801	1,004	484	6,726	3,285
3	60-75	15.4	17.5	98	127	164	160	5,272	3,254	1,440	812	8,470	4,550
4	75-90	17.5	19.2	78	130	157	160	5,616	3,728	1,076	664	9,890	5,688
5	90-105	19.2	20.8	66	133	156	160	6,072	4,191	864	574	11,210	6,725
6	105-120	20.8	22.2	57	135	153	160	6,441	4,560	828	572	12,407	7,666
7	120-135	22.2	23.5	50	134	151	160	6,650	4,850	791	560	13,407	8,516
8	135-150	23.5	24.7	45	136	150	160	6,975	5,085	665	485	14,397	9,236
										7,422	4,151		

Site index 100--20 year thinning interval--$(D+2.2)^2F$ spacing

Start	30	7.9	---	335	---	---	116	1,742	-----	-----	---	1,742	-----
1	30-50	8.4	13.7	176	68	180	157	4,312	2,235	827	---	5,139	2,235
2	50-70	13.7	16.7	115	118	175	160	5,497	3,312	1,495	775	7,819	4,087
3	70-90	16.7	19.1	81	123	161	160	5,832	3,872	1,625	979	9,779	5,626
4	90-110	19.1	21.2	64	127	157	160	6,272	4,416	1,224	813	11,443	6,983
5	110-130	21.2	23.1	53	130	154	160	6,731	4,850	1,078	759	12,980	8,176
6	130-150	23.1	24.9	45	131	152	160	6,975	5,085	1,016	732	14,240	9,143
										7,265	4,058		

1/ See appendix for source or derivation and explanation of columns 1 through 14

TABLE 15.--Calculated growth and yield for hypothetical Ponderosa pine stands of site index 120 for four thinning regimes that give theoretical optimum production [1/]

Site index 120--5-year thinning interval--$(D+0.5)^2F$ spacing

Thinning interval		Diameters		Trees	Basal area--square feet per acre			Residual volume per acre		Volume removed per acre		Volume--residual plus cumulative removed per acre	
					Thinned stand								
No.	Age	Start	End	per acre	Start	End	Unthinned dominant stand	Cu. ft.	Bd. ft. x 10	Cu. ft.	Bd. ft. x 10	Cu. ft.	Bd. ft. x 10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Years	in.	in.	No.									
Start	30	10.2	----	230	---	---	133	2,576	920	---	---	2,576	920
1	30-35	10.7	12.8	195	122	174	150	4,056	1,989	392	140	4,448	2,129
2	35-40	12.8	14.5	159	142	182	162	4,611	2,544	749	367	5,752	3,051
3	40-45	14.5	15.8	135	155	184	169	5,063	2,970	696	384	6,900	3,861
4	45-50	15.8	16.8	119	162	183	174	5,474	3,332	600	352	7,911	4,575
5	50-55	16.8	17.8	108	166	187	176	5,940	3,726	506	308	8,883	5,277
6	55-60	17.8	18.7	96	166	183	177	6,144	3,984	660	414	9,747	5,949
7	60-65	18.7	19.5	87	166	180	178	6,351	4,176	576	374	10,530	6,515
8	65-70	19.5	20.2	81	168	180	178	6,602	4,496	438	288	11,219	7,123
9	70-75	20.2	20.8	75	167	177	178	6,750	4,688	489	333	11,856	7,648
10	75-80	20.8	21.5	71	168	179	178	7,029	4,970	360	250	12,495	8,180
11	80-85	21.5	22.1	67	169	178	178	7,236	5,159	396	280	13,098	8,649
12	85-90	22.1	22.7	63	168	177	178	7,434	5,324	432	308	13,728	9,122
13	90-95	22.7	23.2	60	169	176	178	7,680	5,520	354	254	14,398	9,573
14	95-100	23.2	23.8	57	167	176	178	7,866	5,700	384	276	14,898	10,028
15	100-105	23.8	24.2	55	170	176	178	8,085	5,940	276	200	15,393	10,468
16	105-110	24.2	24.7	53	169	176	178	8,321	6,201	294	216	15,923	10,945
17	110-115	24.7	25.2	51	170	177	178	8,415	6,324	314	234	16,331	11,302
18	115-120	25.2	25.7	49	170	177	178	8,575	6,468	330	248	16,821	11,694
19	120-125	25.7	26.1	47	169	175	178	8,695	6,580	350	264	17,291	12,070
20	125-130	26.1	26.6	46	171	178	178	8,970	6,808	185	140	17,751	12,438
21	130-135	26.6	27.0	44	170	175	178	9,020	6,820	390	296	18,191	12,746
22	135-140	27.0	27.5	43	171	177	178	9,159	7,052	213	164	18,543	13,142
23	140-145	27.5	27.9	41	169	174	178	9,143	7,011	426	328	18,953	13,439
24	145-150	27.9	28.3	40	170	175	178	9,320	7,200	223	171	19,353	13,789
										10,033	6,589		

Site index 120--10-year thinning interval--$(D+1.1)^2F$ spacing

Start	30	10.2	----	230	---	---	133	2,576	920	---	---	2,576	920
1	30-40	10.7	14.5	176	110	202	162	5,104	2,816	605	216	6,583	3,032
2	40-50	14.5	17.0	125	143	197	174	5,750	3,500	1,479	816	7,834	4,532
3	50-60	17.0	18.8	99	156	191	177	6,336	4,109	1,196	728	9,616	5,869
4	60-70	18.8	20.3	81	156	182	178	6,602	4,496	1,152	747	11,034	7,003
5	70-80	20.3	21.6	70	157	178	178	6,930	4,900	897	611	12,259	8,018
6	80-90	21.6	22.8	63	160	179	178	7,434	5,324	693	490	13,456	8,932
7	90-100	22.8	23.9	56	159	174	178	7,728	5,600	836	592	14,576	9,800
8	100-110	23.9	24.9	52	162	176	178	8,164	6,084	552	400	15,564	10,684
9	110-120	24.9	25.9	48	162	176	178	8,400	6,336	628	468	16,428	11,404
10	120-130	25.9	26.9	44	161	174	178	8,580	6,512	700	528	17,208	12,108
11	130-140	26.9	27.8	41	162	173	178	8,733	6,724	585	444	18,046	12,764
12	140-150	27.8	28.6	39	164	174	178	9,087	7,020	426	328	18,926	13,388
										9,739	6,368		

Site index 120--15-year thinning interval--$(D+1.8)^2F$ spacing

Start	30	10.2	----	230	---	---	133	2,576	920	-----	-----	2,576	920
1	30-45	10.7	15.5	157	98	206	169	5,888	3,454	818	292	6,706	3,746
2	45-60	15.5	18.5	105	138	196	177	6,720	4,358	1,950	1,144	9,488	5,794
3	60-75	18.5	20.6	78	146	181	178	7,020	4,875	1,728	1,121	11,516	7,439
4	75-90	20.6	22.4	64	148	175	178	7,552	5,408	1,260	875	13,308	8,810
5	90-105	22.4	24.0	55	151	173	178	8,085	5,940	1,062	761	14,903	10,133
6	105-120	24.0	25.5	48	151	170	178	8,400	6,336	1,029	756	16,247	11,285
7	120-135	25.5	26.9	43	153	170	178	8,815	6,665	875	660	17,537	12,274
8	135-150	26.9	28.2	39	154	169	178	9,087	7,020	800	620	18,620	13,210
										9,549	6,829		

Site index 120--20-year thinning interval--$(D+2.2)^2F$ spacing

Start	30	10.2	----	230	---	---	133	2,576	920	-----	-----	2,576	920
1	30-50	10.7	16.5	147	98	218	169	6,760	4,116	930	332	7,690	4,448
2	50-70	16.5	19.7	92	137	195	178	7,498	5,196	2,530	1,810	10,028	7,006
3	70-90	19.7	22.2	67	142	180	178	7,906	5,660	2,038	1,488	12,066	9,088
4	90-110	22.2	24.4	54	145	175	178	8,178	6,218	1,534	1,099	13,510	10,677
5	110-130	24.4	26.4	46	149	175	178	8,870	6,808	1,056	936	17,258	12,103
6	130-150	26.4	28.2	39	148	169	178	9,087	7,020	1,265	1,026	18,740	13,361
										9,653	6,331		

1/ See appendix for source or derivation and explanation of columns 1 through 14

TABLE 16.--Calculated growth and yield for hypothetical Ponderosa pine stands of site index 140 for four thinning regimes that give theoretical optimum production [1/]

Site index 140--5-year thinning interval--$(D+0.5)^2F$ spacing

Thinning interval		Diameters		Trees per acre	Basal area--square feet per acre			Residual volume per acre		Volume removed per acre		Volume--residual plus cumulative removed per acre	
					Thinned stand								
No.	Age	Start	End		Start	End	Unthinned dominant stand	Cu. ft.	Bd. ft. x 10	Cu. ft.	Bd. ft. x 10	Cu. ft.	Bd. ft. x 10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Years	in.	in.	No.									
Start	30	12.1	----	177	---	---	148	3,629	1,805	---	---	3,629	1,805
1	30-35	12.6	14.9	163	141	197	165	5,542	3,260	287	143	5,829	3,403
2	35-40	14.9	16.8	134	162	206	179	6,432	3,953	986	580	7,705	4,676
3	40-45	16.8	18.2	115	177	208	190	7,015	4,485	912	561	9,200	5,769
4	45-50	18.2	19.4	101	182	207	197	7,474	4,949	854	546	10,513	6,779
5	50-55	19.4	20.4	92	189	209	202	8,004	5,428	666	441	11,709	7,699
6	55-60	20.4	21.3	83	188	205	204	8,217	5,644	783	531	12,705	8,446
7	60-65	21.3	22.2	76	188	204	205	8,512	5,890	693	476	13,693	9,168
8	65-70	22.2	23.0	70	188	202	205	8,680	6,090	672	465	14,533	9,833
9	70-75	23.0	23.7	66	190	202	205	8,844	6,369	496	348	15,193	10,460
10	75-80	23.7	24.3	62	190	200	205	9,114	6,634	536	386	15,999	11,111
11	80-85	24.3	24.9	59	190	200	205	9,322	6,962	441	321	16,648	11,760
12	85-90	24.9	25.5	56	189	199	205	9,520	7,112	474	354	17,320	12,264
13	90-95	25.5	26.1	54	192	201	205	9,882	7,452	340	254	18,022	12,858
14	95-100	26.1	26.7	51	189	198	205	9,843	7,497	549	414	18,532	13,317
15	100-105	26.7	27.2	49	191	198	205	10,045	7,693	386	294	19,120	13,807
16	105-110	27.2	27.7	47	190	197	205	10,105	7,896	410	314	19,590	14,324
17	110-115	27.7	28.2	46	193	200	205	10,488	8,188	215	168	20,188	14,784
18	115-120	28.2	28.6	44	191	196	205	10,560	8,184	456	356	20,716	15,136
19	120-125	28.6	29.1	43	192	199	205	10,750	8,299	240	186	21,146	15,437
20	125-130	29.1	29.6	41	189	196	205	10,660	8,323	500	386	21,556	15,847
21	130-135	29.6	30.0	40	191	196	205	10,880	8,520	260	203	22,036	16,247
22	135-140	30.0	30.5	39	191	198	205	10,998	8,619	272	213	22,426	16,559
23	140-145	30.5	30.9	38	193	198	205	11,096	8,702	282	221	22,806	16,863
24	145-150	30.9	31.4	37	193	199	205	11,174	8,769	292	229	23,176	17,159
										12,002	8,390		
	Site index 140--10-year thinning interval-$(D+1.1)^2F$ spacing												
Start	30	12.1	----	177	---	---	148	3,629	1,805	---	---	3,629	1,805
1	30-40	12.6	16.8	149	129	229	179	7,152	4,396	574	286	7,726	4,682
2	40-50	16.8	19.6	107	165	224	204	7,918	5,243	2,016	1,239	10,508	6,768
3	50-60	19.6	21.4	85	178	212	205	8,415	5,780	1,628	1,078	12,633	8,383
4	60-70	21.4	23.1	72	180	210	205	8,928	6,264	1,287	884	14,433	9,751
5	70-80	23.1	24.4	62	180	201	205	9,114	6,634	1,240	870	15,859	10,991
6	80-90	24.4	25.7	56	182	202	205	9,520	7,112	882	642	17,147	12,111
7	90-100	25.7	26.8	51	184	200	205	9,843	7,497	850	635	18,320	13,131
8	100-110	26.8	27.9	47	184	200	205	10,105	7,896	772	588	19,354	14,118
9	110-120	27.9	28.9	43	183	196	205	10,320	7,998	860	672	20,429	14,892
10	120-130	28.9	29.8	40	182	194	205	10,400	8,120	720	558	21,229	15,572
11	130-140	29.8	30.8	38	184	197	205	10,716	8,398	520	406	22,065	16,256
12	140-150	30.8	31.6	36	186	196	205	10,872	8,532	564	442	22,785	16,832
										11,913	8,300		
	Site index 140--15-year thinning interval-$(D+1.8)^2F$ spacing												
Start	30	12.1	----	177	---	---	148	3,629	1,805	---	---	3,629	1,805
1	30-45	12.6	17.9	135	117	236	190	8,235	5,265	861	428	9,096	5,693
2	45-60	17.9	21.0	91	159	219	204	9,009	6,188	2,684	1,716	12,554	8,332
3	60-75	21.0	23.3	70	168	207	205	9,380	6,755	2,079	1,428	15,004	10,327
4	75-90	23.3	25.1	58	172	199	205	9,860	7,366	1,608	1,158	17,092	12,096
5	90-105	25.1	26.8	50	172	196	205	10,250	7,850	1,360	1,016	18,842	13,596
6	105-120	26.8	28.3	44	172	192	205	10,500	8,184	1,230	942	20,382	14,872
7	120-135	28.3	29.8	40	175	194	205	10,880	8,520	960	744	21,662	15,952
8	135-150	29.8	31.2	36	174	191	205	10,872	8,532	1,088	852	22,742	16,816
										11,870	8,284		
	Site index 140--20-year thinning interval-$(D+2.2)^2F$ spacing												
Start	30	12.1	----	177	---	---	148	3,629	1,805	---	---	3,629	1,805
1	30-50	12.6	18.8	127	110	245	197	9,398	6,223	1,025	510	10,423	6,773
2	50-70	18.8	22.3	82	158	222	205	10,168	7,134	3,330	2,205	14,523	9,849
3	70-90	22.3	24.8	61	165	205	205	10,370	7,747	2,604	1,827	17,329	12,289
4	90-110	24.8	27.1	50	168	200	205	10,750	8,400	1,870	1,397	19,579	14,339
5	110-130	27.1	29.1	42	168	194	205	10,920	8,526	1,720	1,344	21,469	15,809
6	130-150	29.1	30.9	37	171	193	205	11,174	8,769	1,300	1,015	23,023	17,067
										11,849	8,298		

1/ See appendix for source or deviation and explanation of columns 1 through 14.

EXPLANATION OF TABLES 17, 18, 19, 20, and 21
(unpublished except for Table 18)

These are some of the complete sets of calculated growth and yield information for site classes 60, 80, 100, 120, and 140 using the $(D+6)^2$ spacing formula and different thinning interval lengths. Table 18 for site index 80 was published as an example in Forest Science 9: (1) 33-43, March, 1963. An explanation of the computations by column number is included with explanation for tables 12, 13, 14, 15, and 16 on the preceding section.

TABLE 17.--Calculated growth and yield for hypothetical Ponderosa pine stands of site index 60 for three thinning regimes using the $(D+6)^2$ spacing formula [1/]

Site index 60--5 year thinning interval--$(D+6)^2$ spacing

Thinning interval		Diameters		Trees per acre	Basal area--square feet per acre			Residual volume per acre		Volume removed per acre		Volume--residual plus cumulative removed per acre	
					Thinned stand		Unthinned dominant stand						
No.	Age	Start	End		Start	End		Cu. ft.	Bd. ft. x 10	Cu. ft.	Bd. ft. x 10	Cu. ft.	Bd. ft. x 10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Years	in.	in.	No.									
Start	30	3.5	---	1,100	---	---	93	-----	-----	-----	-----	-----	-----
1	30-35	4.0	4.6	436	38	50	104	523	-----	-----	-----	523	-----
2	35-40	4.6	5.2	389	45	57	109	661	-----	56	-----	717	-----
3	40-45	5.2	5.7	348	51	62	112	766	-----	70	-----	892	-----
4	45-50	5.7	6.2	318	56	67	115	890	-----	66	-----	1,082	-----
5	50-55	6.2	6.7	292	61	71	116	1,022	-----	73	-----	1,287	-----
6	55-60	6.7	7.1	271	66	74	117	1,138	-----	74	-----	1,477	-----
7	60-65	7.1	7.5	253	70	78	118	1,240	-----	76	-----	1,655	-----
8	65-70	7.5	7.9	239	73	81	118	1,362	-----	69	-----	1,846	-----
9	70-75	7.9	8.3	226	77	85	118	1,492	271	74	-----	2,050	271
10	75-80	8.3	8.7	214	80	88	118	1,626	364	79	14	2,263	378
11	80-85	8.7	9.1	202	83	91	118	1,757	465	91	20	2,485	499
12	85-90	9.1	9.5	191	86	94	118	1,872	573	96	25	2,696	632
13	90-95	9.5	9.9	182	90	97	118	2,002	692	68	27	2,914	778
14	95-100	9.9	10.3	172	92	100	118	2,116	791	110	38	3,138	915
15	100-105	10.3	10.7	164	95	102	118	2,247	918	98	37	3,367	1,079
16	105-110	10.7	11.0	156	97	103	118	2,309	1,030	110	45	3,539	1,236
17	110-115	11.0	11.3	151	100	105	118	2,446	1,148	74	33	3,750	1,387
18	115-120	11.3	11.6	146	102	107	118	2,555	1,256	81	38	3,940	1,533
19	120-125	11.6	11.9	141	103	109	118	2,679	1,368	88	43	4,152	1,688
20	125-130	11.9	12.2	136	105	110	118	2,774	1,469	95	49	4,342	1,838
21	130-135	12.2	12.5	132	107	112	118	2,891	1,584	82	43	4,541	1,996
22	135-140	12.5	12.8	127	108	113	118	2,959	1,651	110	60	4,719	2,123
23	140-145	12.8	13.1	123	110	115	118	3,038	1,759	93	52	4,891	2,283
24	145-150	13.1	13.4	119	111	117	118	3,142	1,821	99	57	5,094	2,402
25	150-155	13.4	13.7	116	114	119	118	3,236	1,902	79	46	5,267	2,529
26	155-160	13.7	14.0	112	115	120	118	3,326	1,960	112	66	5,469	2,653
27	160-165	14.0	14.3	109	117	122	118	3,444	2,027	89	53	5,676	2,773
28	165-170	14.3	14.6	106	118	123	118	3,540	2,141	95	56	5,867	2,943
										2,327	802		

Site index 60--15 year thinning interval--$(D+6)^2$ spacing

Start	30	3.5	---	1,100	---	---	93	-----	-----	-----	-----	-----	-----
1	30-45	4.0	5.7	436	36	77	112	959	-----	-----	-----	959	-----
2	45-60	5.7	7.1	318	56	87	117	1,336	-----	260	-----	1,596	-----
3	60-75	7.1	8.3	253	70	96	118	1,670	304	273	-----	2,203	304
4	75-90	8.3	9.5	214	80	105	118	2,097	642	257	47	2,887	689
5	90-105	9.5	10.6	182	90	112	118	2,457	1,001	314	96	3,561	1,144
6	105-120	10.6	11.5	158	97	114	118	2,765	1,296	324	132	4,193	1,571
7	120-135	11.5	12.4	142	102	119	118	3,096	1,676	280	131	4,804	2,082
8	135-150	12.4	13.3	128	107	123	118	3,354	1,920	305	165	5,367	2,491
9	150-165	13.3	14.2	117	113	129	118	3,650	2,165	288	165	5,951	2,901
										2,301	736		

Site index 60--20 years thinning interval--$(D+6)^2$ spacing

Start	30	3.5	---	1,100	---	---	93	-----	-----	-----	-----	-----	-----
1	30-50	4.0	6.2	436	38	91	115	1,221	-----	-----	-----	1,221	-----
2	50-70	6.2	7.9	292	61	99	118	1,664	-----	403	-----	2,067	-----
3	70-90	7.9	9.5	226	77	111	118	2,215	678	376	-----	2,994	678
4	90-110	9.5	10.9	182	90	118	118	2,657	1,165	431	132	3,867	1,297
5	110-130	10.9	12.1	152	98	121	118	3,040	1,596	438	192	4,688	1,920
6	130-150	12.1	13.3	133	106	128	118	3,465	1,995	380	200	5,513	2,519
7	150-170	13.3	14.5	117	113	134	118	3,861	2,317	419	240	6,308	3,081
										2,447	764		

1/ See appendix for source or derivation and explanation of columns 1 through 14.

TABLE 18--Calculated growth and yield for hypothetical Ponderosa pine stands of site index 80 for three thinning regimes using the $(D+6)^2$ spacing formula

Site index 80--5 year thinning interval--$(D+6)^2$ spacing

Thinning interval		Diameters		Trees per acre	Basal area--square feet per acre			Residual volume per acre		Volume removed per acre		Volume--residual plus cumulative removed per acre	
					Thinned stand								
No.	Age	Start	End		Start	End	Unthinned dominant stand	Cu. ft.	Bd. ft. in tens	Cu. ft.	Bd. ft. in tens	Cu. ft.	Bd. ft. in tens
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Years	in.	in.	No.									
Start	30	5.4	---	635	---	---	102	1,270	-----	-----	-----	1,270	-----
1	30-35	5.9	7.1	307	58	84	115	1,105	-----	656	-----	1,761	-----
2	35-40	7.1	8.2	253	70	93	124	1,341	278	194	-----	2,191	278
3	40-45	8.2	9.1	216	79	98	131	1,555	410	196	41	2,601	451
4	45-50	9.1	9.9	191	86	102	135	1,776	592	180	48	3,002	681
5	50-55	9.9	10.6	172	92	105	137	2,030	774	177	60	3,433	923
6	55-60	10.6	11.3	158	97	110	139	2,259	980	165	63	3,827	1,192
7	60-65	11.3	11.9	146	102	113	139	2,482	1,183	172	74	4,222	1,469
8	65-70	11.9	12.5	136	105	116	139	2,720	1,387	170	81	4,630	1,754
9	70-75	12.5	13.1	127	108	119	139	2,908	1,588	180	92	4,998	2,047
10	75-80	13.1	13.6	119	111	120	139	3,094	1,773	183	100	5,367	2,332
11	80-85	13.6	14.1	113	114	123	139	3,322	1,955	156	89	5,751	2,603
12	85-90	14.1	14.6	108	117	126	139	3,510	2,106	147	87	6,086	2,841
13	90-95	14.6	15.1	103	120	128	139	3,739	2,266	163	98	6,478	3,099
14	95-100	15.1	15.6	98	122	130	139	3,900	2,421	182	110	6,821	3,364
15	100-105	15.6	16.1	93	123	131	139	4,055	2,548	199	124	7,175	3,615
16	105-110	16.1	16.5	89	126	132	139	4,192	2,634	174	110	7,486	3,811
17	110-115	16.5	16.9	86	128	134	139	4,343	2,795	141	89	7,778	4,061
										3,435	1,266		

Site index 80--10 year thinning interval--$(D+6)^2$ spacing

Start	30	5.4	---	635	---	---	102	1,270	-----	-----	-----	1,270	-----
1	30-40	5.9	8.1	307	58	110	124	1,596	338	656	-----	2,252	338
2	40-50	8.1	9.8	219	78	115	135	2,015	635	458	97	3,129	732
3	50-60	9.8	11.2	174	91	119	139	2,453	1,044	414	131	3,981	1,272
4	60-70	11.2	12.4	147	101	123	139	2,867	1,441	381	162	4,776	1,831
5	70-80	12.4	13.5	128	107	127	139	3,277	1,882	371	186	5,557	2,458
6	80-90	13.5	14.5	115	114	132	139	3,692	2,070	333	191	6,305	2,837
7	90-100	14.5	15.4	104	119	135	139	4,025	2,496	353	198	6,991	3,461
8	100-110	15.4	16.2	95	123	136	139	4,304	2,708	348	216	7,618	3,889
										3,314	1,181		

Site index 80--12 year thinning interval--$(D+6)^2$ spacing

Start	30	5.4	---	635	---	---	102	1,270	-----	-----	-----	1,270	-----
1	30-42	5.9	8.4	307	58	118	127	1,811	368	656	-----	2,467	368
2	42-54	8.4	10.4	210	81	124	137	2,352	819	572	116	3,580	935
3	54-66	10.4	11.9	162	96	125	139	2,803	1,345	538	187	4,569	1,648
4	66-78	11.9	13.2	136	105	129	139	3,264	1,809	450	216	5,480	2,328
5	78-90	13.2	14.4	118	112	133	139	3,729	2,089	432	239	6,377	2,847
6	90-102	14.4	15.5	105	119	138	139	4,169	2,625	411	230	7,228	3,613
7	102-114	15.5	16.5	94	123	140	139	4,512	2,867	437	275	8,008	4,130
										3,496	1,263		

TABLE 19.--Calculated growth and yield for hypothetical Ponderosa pine stands of site index 100 for two thinning regimes using the $(D+6)^2$ spacing formula.[1/]

Site index 100--5 year thinning interval--$(D+6)^2$ spacing

Thinning interval		Diameters		Trees per acre	Basal area--square feet per acre			Residual volume per acre		Volume removed per acre		Volume--residual plus cumulative removed per acre	
No.	Age	Start	End		Thinned stand		Unthinned dominant stand	Cu. ft.	Bd. ft. x 10	Cu. ft.	Bd. ft. x 10	Cu. ft.	Bd. ft. x 10
					Start	End							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Years	in.	in.	No.									
Start	30	7.9	----	335	---	---	116	1,742	-----	---	---	1,742	-----
1	30-35	8.4	10.2	210	81	119	133	2,142	693	650	---	2,792	693
2	35-40	10.2	11.7	166	94	124	146	2,523	1,013	449	145	3,622	1,158
3	40-45	11.7	12.9	139	104	126	153	2,780	1,348	410	165	4,289	1,658
4	45-50	12.9	13.9	122	111	129	157	3,111	1,671	340	165	4,960	2,146
5	50-55	13.9	14.8	110	116	131	159	3,366	1,947	306	164	5,521	2,586
6	55-60	14.8	15.6	101	121	134	160	3,687	2,192	275	159	6,117	2,990
7	60-65	15.6	16.3	93	123	135	160	3,860	2,372	292	174	6,582	3,344
8	65-70	16.3	17.0	88	128	139	160	4,180	2,622	208	128	7,110	3,722
9	70-75	17.0	17.6	82	129	139	160	4,428	2,788	285	179	7,643	4,067
10	75-80	17.6	18.2	78	132	141	160	4,657	2,886	216	136	8,088	4,301
11	80-85	18.2	18.8	74	134	143	160	4,847	3,219	239	148	8,517	4,782
12	85-90	18.8	19.4	71	137	146	160	5,112	3,408	197	131	8,979	5,102
13	90-95	19.4	19.9	68	140	147	160	5,372	3,604	216	144	9,455	5,442
										4,083	1,838		

Site index 100--9 year thinning interval--$(D+6)^2$ spacing

Start	30	7.9	----	335	---	---	116	1,742	-----	---	---	1,742	-----
1	30-39	8.4	11.3	210	81	146	141	2,814	1,092	655	---	3,469	1,092
2	39-48	11.3	13.3	146	102	141	154	3,238	1,679	858	333	4,751	2,012
3	48-57	13.3	14.9	117	113	142	159	3,731	2,106	643	334	5,887	2,773
4	57-66	14.9	16.2	100	121	143	160	4,167	2,400	542	306	6,865	3,373
5	66-75	16.2	17.2	88	126	142	160	4,481	2,816	500	288	7,679	4,077
6	75-84	17.2	18.2	82	132	148	160	5,002	3,280	306	192	8,506	4,733
7	84-93	18.2	19.1	74	134	147	160	5,292	3,552	488	320	9,284	5,325
										3,992	1,773		

[1/] See appendix for source or derivation and explanation of columns 1 through 14

TABLE 20.--Calculated growth and yield for hypothetical Ponderosa pine stands of site index 120 for 2 thinning regimes using the $(D+6)^2$ spacing formula[1/]

Site index 120--5 year thinning interval--$(D+6)^2$ spacing

Thinning cycle		Diameters		Trees per acre	Basal area--square feet per acre			Residual volume per acre		Volume removed per acre		Volume--residual plus cumulative removed per acre	
					Thinned stand								
No.	Age	Start	End		Start	End	Unthinned dominant stand	Cu. ft.	Bd. ft. X 10	Cu. ft.	Bd. ft. X 10	Cu. ft.	Bd. ft. X 10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Years	in.	in.	No.									
Start	30	10.2	----	230	---	---	133	2,576	920	---	---	2,576	920
1	30-35	10.7	12.9	156	97	142	150	3,292	1,685	829	296	4,121	1,981
2	35-40	12.9	14.6	122	111	142	162	3,684	2,159	717	367	5,230	2,822
3	40-45	14.6	16.0	103	120	144	169	4,069	2,451	574	336	6,189	3,450
4	45-50	16.0	17.2	90	127	145	174	4,374	2,745	514	309	7,008	4,053
5	50-55	17.2	18.2	81	131	146	176	4,681	3,013	437	275	7,752	4,596
6	55-60	18.2	19.1	74	134	147	177	4,928	3,271	405	260	8,404	5,114
7	60-65	19.1	19.9	69	137	149	178	5,265	3,519	333	221	9,074	5,583
8	65-70	19.9	20.6	65	140	150	178	5,525	3,770	305	204	9,639	6,038
9	70-75	20.6	21.3	62	143	153	178	5,909	4,030	255	174	10,278	6,472
10	75-80	21.3	21.9	58	144	152	178	5,980	4,205	381	260	10,730	6,907
										4,750	2,702		

Site index 120--7 year thinning interval--$(D+6)^2$ spacing

Start	30	10.2	----	230	---	---	133	2,576	920	---	---	2,576	920
1	30-37	10.7	13.5	156	97	155	155	3,744	1,825	829	296	4,573	2,121
2	37-44	13.5	15.5	115	114	151	168	4,152	2,530	984	480	5,965	3,306
3	44-51	15.5	17.1	94	123	150	174	4,568	2,914	758	462	7,139	4,152
4	51-58	17.1	18.4	82	131	151	177	4,994	3,239	583	372	8,148	4,849
5	58-65	18.4	19.5	73	135	151	178	5,329	3,504	548	356	9,031	5,470
6	65-72	19.5	20.5	67	139	154	178	5,809	3,953	438	288	9,949	6,207
7	72-79	20.5	21.4	62	142	155	178	6,095	4,216	434	295	10,669	6,765
										4,574	2,549		

[1/] See appendix for source or derivation and explanation of columns 1 through 14.

TABLE 21.--Calculated growth and yield for hypothetical Ponderosa pine stands of site index 140 for two thinning regimes using the $(D+6)^2$ spacing formula[1/]

Site index 140--5 year thinning interval--$(D+6)^2$ spacing

Thinning cycle		Diameters		Trees per acre	Basal area--square feet per acre			Residual volume per acre		Volume removed per acre		Volume--residual plus cumulative removed per acre	
					Thinned stand								
No.	Age	Start	End		Start	End	Unthinned dominant stand	Cu. ft.	Bd. ft. X 10	Cu. ft.	Bd. ft. X 10	Cu. ft.	Bd. ft. X 10
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Years	in.	in.	No.									
Start	30	12.1	----	177	---	---	148	3,629	1,805	-----	---	3,629	1,805
1	30-35	12.6	15.0	126	109	155	165	4,473	2,709	1,046	520	5,519	3,229
2	35-40	15.0	16.8	99	121	152	179	4,752	3,109	959	581	6,757	4,210
3	40-45	16.8	18.3	84	129	153	190	5,258	3,444	720	471	7,983	5,016
4	45-50	18.3	19.5	74	135	153	197	5,594	3,774	626	410	8,945	5,756
5	50-55	19.5	20.6	67	139	155	202	5,983	4,121	529	357	9,863	6,460
6	55-60	20.6	21.5	62	143	156	204	6,287	4,402	447	308	10,614	7,049
7	60-65	21.5	22.3	58	146	157	205	6,612	4,698	406	284	11,345	7,629
8	65-70	22.3	23.1	54	146	157	205	6,804	4,968	456	324	11,993	8,223
										5,189	3,255		

Site index 140--7 year thinning interval--$(D+6)^2$ spacing

Start	30	12.1	----	177	---	---	148	3,629	1,805	-----	---	3,629	1,805
1	30-37	12.6	15.7	126	109	170	171	5,103	3,226	1,046	520	6,149	3,746
2	37-44	15.7	17.9	92	124	161	188	5,520	3,496	1,377	870	7,943	4,886
3	44-51	17.9	19.6	76	133	159	198	5,928	3,952	960	608	9,311	5,950
4	51-58	19.6	21.0	67	140	161	204	6,432	4,355	702	468	10,517	6,821
5	58-65	21.0	22.2	60	144	161	205	6,780	4,800	672	455	11,537	7,721
6	65-72	22.2	23.3	55	148	163	205	7,150	5,225	565	400	12,472	8,546
										5,322	3,321		

[1/] See appendix for source or derivation and explanation of columns 1 through 14.

EXPLANATION OF VOLUME EQUATIONS (unpublished)

Volume calculations. Application of regression equations I, II, III, and IV to hypothetical timber stands to study results from different theoretical thinning regimes required volume determinations. As for the original data used in the development of the equations, volume tables published by Meyer were used.

The multitude of volume calculations by means of the 650 electrical computer required mathematical expression of tree volumes in terms of d.b.h. (D) and total height (H). But the tables used were based primarily on free-hand curves. Accordingly, the required equations of tree volume given below, are based upon values in the tables rather than upon the actual values representing measurements of tree volumes which provided the published tables. As a consequence, tests of significance are not valid, although derived equations must fit the tabular data more than reasonably well, based upon the following considerations:

For a fixed total height (H), tree volume should be accurately given in terms of d.b.h. (D) by

$$V = a + bD + cD^2$$

where V is tree volume.

Each of the coefficients a, b, and c may be taken as a linear function of tree height (H), such as

$$a = a_o + a_1H$$

$$b = b_o + b_1H$$

$$c = c_o + c_1H$$

and upon inserting these equivalents into the original form

$$V = a_o + a_1H + (b_o + b_1H)\ D + (c_o + c_1H)\ D^2$$

And upon parenthesizing the independent variables

$$V = a_o + a_1\ (H) + b_o\ (D) + b_1\ (DH) + c_o\ (D^2) + c_1\ (D^2H)$$

It is well known that the relative discrepancy between the actual volume of a random tree and the corresponding tabular volume is about the same in a small and big tree, whereas the corresponding discrepancy in the actual volume unit is very much greater in the big tree. In the present discussion, accordingly, the discrepancies between actual volume and corresponding tabular volume should be weighted inversely proportional to the square of tabular volume. Hence the sum of squares of residuals (S) to be made minimum is

$$S = \left[1 - a_o\ (1/V) - a_1\ (H/V) - b_o\ (D/V) - b_1\ (DH/V) - c_o\ (D^2/V) - c_1\ (D^2H/V)\right]^2$$

About 100 observations from each of the three tables (32, 33, and 34, Meyer 1938) were used in calculating the equations expressing volume, the outcome of which follows:

If V_1 is the volume in cubic feet of the entire tree including stump and tip but not bark or branches, then

$$V_1 = 2.283 - 0.03666\ (H) + \left[0.01039\ (H) - 0.63695\right]\ (D) + \left[0.001376\ (H) + 0.03941\right]\ (D^2)$$

If V_2 is the volume in board feet (International rule 1/8-inch kerf) stump to 6.0-inch top d.i.b. then

$$V_2 = 16.80 - 0.3566\ (H) + \left[0.04443\ (H) - 2.5731\right]\ (D) + \left[0.000384\ (H) + 0.05758\right]\ (D^2)$$

If V_3 is the volume in board feet (Scribner rule) stump to 8.0-inch top d.i.b. then

$$V_3 = 16.16 - 0.3464\ (H) + \left[0.03446\ (H) - 2.1592\right] (D) + \left[0.000484\ (H) + 0.04375\right] (D^2)$$

Appendix table 1.--Individual tree measurements

Tree No.	Various expressions of basal area density [1]																Diam. b. h.	Total height	Total age	Site index	Overstory density	Periodic volume		Radial growth in last 5 years	Rings per last radial inch
	Modified		F-10		F-20		F-30		F-40		Ave. F-10,20,30,40		Ave. F-10 and F-20		Ave. F-30 and F-40							Last 5 years	Last 10 years		
	Total X_1	D+C X_2	Total X_4	D+C X_5	Total X_7	D+C X_8	Total X_{10}	D+C X_{11}	Total X_{13}	D+C X_{14}	Total X_{16}	D+C X_{17}	Total X_{19}	D+C X_{20}	Total X_{22}	D+C X_{23}	X_{25}	X_{26}	X_{27}	X_{28}	X_{29}	Y_1	Y_2	Y_3	Y_4
																	Inches	Feet	Years		Percent	Cu. ft.	Cu. ft.	Inches	
1	153	--	140	--	160	--	180	--	160	--	160	--	150	--	170	--	13.2	73	98	74	--	.70	.62	.33	15.0
4	95	--	130	--	60	--	60	--	40	--	73	--	95	--	50	--	27.0	92	110	87	--	2.80	2.30	.42	12.0
5	133	--	100	--	120	--	150	--	160	--	94	--	110	--	155	--	20.1	88	94	91	--	1.54	1.36	.33	15.0
7	155	--	100	--	140	--	180	--	200	--	155	--	120	--	190	--	18.0	81	116	75	--	1.11	.94	.33	15.0
10	193	--	160	--	100	--	210	--	240	--	193	--	160	--	225	--	19.1	82	70	102	--	1.64	1.28	.46	11.0
11	130	--	120	--	120	--	120	--	160	--	130	--	120	--	140	--	23.4	105	76	122	--	2.40	2.41	.42	12.0
17	233	--	170	--	200	--	240	--	320	--	233	--	185	--	280	--	20.9	110	148	89	--	1.10	1.08	.20	25.0
18	250	--	180	--	260	--	240	--	320	--	250	--	220	--	280	--	21.5	121	150	97	--	1.36	1.33	.24	21.0
26	240	--	240	--	240	--	240	--	240	--	240	--	240	--	240	--	16.0	62	104	62	--	.25	.35	.15	33.0
31	400	--	350	--	460	--	510	--	520	--	460	--	405	--	515	--	25.0	110	118	100	--	1.08	1.20	.14	35.0
32	468	--	340	--	460	--	510	--	560	--	468	--	400	--	535	--	26.1	101	141	84	--	1.12	1.10	.15	33.0
33	230	--	200	--	220	--	300	--	200	--	230	--	210	--	250	--	26.9	115	156	91	--	1.68	1.58	.24	21.0
34	140	--	130	--	120	--	150	--	160	--	140	--	125	--	155	--	27.1	99	151	80	--	1.06	1.17	.18	28.0
37	125	--	130	--	120	--	90	--	120	--	115	--	125	--	105	--	16.9	55	42	97	--	1.57	1.52	.71	7.0
38	180	--	160	--	150	--	180	--	240	--	183	--	155	--	210	--	10.6	47	40	87	--	.46	.47	.45	11.0
39	265	--	210	--	320	--	330	--	240	--	275	--	270	--	285	--	13.3	66	95	68	--	.50	.48	.24	21.0
40	147	--	140	--	160	--	90	--	120	--	128	--	150	--	105	--	10.3	55	89	58	--	.75	.63	.28	18.0
43	139	--	100	--	180	--	150	--	120	--	138	--	140	--	135	--	9.6	59	68	75	--	.49	.43	.46	11.0
44	102	--	120	--	80	--	90	--	120	--	103	--	100	--	105	--	11.7	60	60	83	--	.82	.77	.63	8.0
45	113	--	90	--	120	--	120	--	120	--	113	--	105	--	120	--	18.7	81	61	109	--	2.18	2.10	.71	7.0
46	151	--	130	--	180	--	180	--	160	--	163	--	155	--	170	--	15.0	82	60	111	--	1.97	1.76	.83	6.0
47	216	--	210	--	220	--	210	--	200	--	210	--	215	--	205	--	15.8	83	60	112	--	1.70	1.61	.63	8.0
48	187	--	180	--	200	--	180	--	200	--	190	--	190	--	190	--	12.8	78	63	104	--	1.26	1.13	.63	8.0
49	99	--	80	--	100	--	150	--	160	--	123	--	90	--	155	--	12.7	75	57	105	--	1.30	1.26	.71	7.0
50	162	--	200	--	160	--	150	--	160	--	168	--	180	--	155	--	9.6	55	56	80	--	.49	.44	.50	11.0
51	121	--	130	--	120	--	120	--	120	--	123	--	125	--	120	--	9.5	60	59	81	--	.48	.39	.33	15.0
52	51	--	60	--	40	--	60	--	80	--	60	--	50	--	70	--	13.9	51	59	72	--	1.03	.95	.71	7.0
53	64	--	70	--	60	--	90	--	120	--	85	--	65	--	105	--	14.2	53	69	67	--	1.04	.97	.71	7.0
54	32	--	40	--	20	--	30	--	40	--	33	--	30	--	35	--	10.6	40	54	63	--	.45	.39	.56	9.0
55	108	--	90	--	100	--	120	--	120	--	108	--	95	--	120	--	16.6	68	112	64	--	.67	.65	.26	19.0

Appendix--Continued

56	36	--	30	--	40	--	60	--	40	--	43	--	35	--	50	--	14.8	72	120	65	--	.94	.98	.50	10.0
57	144	--	150	--	140	--	150	--	160	--	150	--	145	--	155	--	15.7	75	62	101	--	1.31	1.32	.57	8.6
58	103	--	100	--	120	--	150	--	160	--	133	--	110	--	155	--	15.7	79	63	104	--	1.28	1.29	.40	10.4
59	68	--	70	--	60	--	60	--	80	--	68	--	65	--	70	--	21.3	72	38	127	--	2.76	2.87	.63	7.3
60	172	--	140	--	160	--	210	--	240	--	188	--	150	--	225	--	11.5	68	51	103	--	.76	.72	.39	11.1
61	90	--	70	--	80	--	90	--	120	--	90	--	75	--	105	--	16.7	62	110	59	--	.72	.85	.35	13.8
62	57	--	70	--	40	--	30	--	40	--	45	--	55	--	35	--	14.4	59	65	77	--	.75	.73	.36	12.5
63	49	--	50	--	60	--	90	--	120	--	80	--	55	--	105	--	15.1	64	93	67	--	.72	.75	.36	13.0
64	57	--	50	--	60	--	60	--	40	--	53	--	55	--	50	--	15.3	55	67	71	--	.94	.93	.44	10.3
65	140	--	70	--	120	--	150	--	200	--	135	--	95	--	175	--	10.2	48	41	87	--	.49	.49	.49	9.3
66	320	--	150	--	240	--	360	--	320	--	268	--	195	--	340	--	7.5	41	44	74	--	.16	.17	.18	15.6
67	160	--	140	--	180	--	180	--	160	--	165	--	160	--	170	--	12.5	56	60	77	--	.49	.54	.28	14.5
68	129	--	110	--	160	--	120	--	160	--	138	--	135	--	140	--	12.7	56	56	81	--	.50	.58	.31	15.5
69	209	--	180	--	180	--	240	--	200	--	200	--	180	--	220	--	9.2	42	44	75	--	.30	.27	.33	14.3
70	79	--	120	--	80	--	90	--	40	--	83	--	100	--	65	--	10.1	37	44	69	--	.18	.30	.36	12.4
71	28	--	20	--	20	--	30	--	40	--	28	--	20	--	35	--	17.6	52	126	46	--	.41	.41	.20	19.8
72	63	--	70	--	60	--	60	--	80	--	68	--	65	--	70	--	16.1	62	106	60	--	.46	.36	.13	34.5
73	56	--	60	--	40	--	60	--	40	--	50	--	50	--	50	--	16.1	55	64	74	--	.91	.54	.46	9.6
74	82	--	70	--	100	--	150	--	200	--	130	--	85	--	175	--	13.9	58	62	79	--	.70	.71	.36	11.8
75	124	--	110	--	140	--	90	--	80	--	105	--	125	--	85	--	15.3	62	66	80	--	1.10	1.13	.54	8.5
76	106	--	120	--	80	--	120	--	120	--	110	--	100	--	120	--	13.0	71	72	87	--	.68	.71	.32	13.5
77	137	--	120	--	160	--	180	--	160	--	155	--	140	--	170	--	15.2	71	61	96	--	.95	1.00	.36	12.0
78	199	--	190	--	200	--	270	--	280	--	235	--	195	--	275	--	13.8	73	60	100	--	.92	.94	.38	11.5
79	160	--	180	--	140	--	120	--	160	--	150	--	160	--	140	--	18.3	76	63	101	--	1.70	1.77	.55	7.7
80	146	--	160	--	180	--	120	--	120	--	145	--	170	--	120	--	10.6	61	60	84	--	.54	.57	.42	9.8
81	101	--	120	--	80	--	60	--	80	--	85	--	100	--	70	--	14.2	64	53	96	--	1.24	1.06	.54	8.5
82	225	--	210	--	240	--	240	--	240	--	233	--	225	--	240	--	12.7	63	55	91	--	.75	.71	.38	12.0
83	207	--	200	--	220	--	210	--	200	--	208	--	210	--	205	--	9.3	56	56	81	--	.32	.32	.29	13.5
84	113	--	130	--	100	--	120	--	80	--	108	--	115	--	100	--	11.4	66	56	94	--	.62	.62	.37	12.3
85	233	--	200	--	280	--	330	--	300	--	293	--	240	--	345	--	14.1	85	60	114	--	1.25	1.20	.46	10.25
86	225	--	200	--	280	--	270	--	280	--	258	--	240	--	275	--	15.7	87	60	117	--	1.53	1.62	.59	8.3
87	230	--	130	--	200	--	270	--	320	--	230	--	165	--	295	--	17.2	87	59	118	--	2.04	2.02	.64	6.8
88	233	--	220	--	200	--	270	--	240	--	233	--	210	--	255	--	18.3	98	84	108	--	1.41	1.35	.28	17.0
89	200	--	180	--	220	--	180	--	160	--	185	--	200	--	170	--	21.0	99	84	109	--	1.87	1.88	.35	15.3
90	185	--	170	--	200	--	150	--	160	--	170	--	185	--	155	--	20.3	91	84	101	--	1.28	1.23	.23	22.3
91	185	--	160	--	160	--	180	--	240	--	185	--	160	--	210	--	16.7	90	84	100	--	.98	.99	.27	18.8
92	236	--	210	--	260	--	270	--	240	--	236	--	235	--	255	--	13.0	84	81	94	--	.72	.65	.25	18.8
93	209	--	100	--	280	--	240	--	280	--	225	--	190	--	260	--	11.2	71	63	94	--	.61	.61	.37	12.5
94	162	--	140	--	140	--	150	--	200	--	158	--	140	--	175	--	10.0	72	67	91	--	.57	.51	.33	16.8
95	249	--	170	--	200	--	240	--	280	--	223	--	185	--	260	--	9.2	67	70	83	--	.35	.34	.26	17.3

Appendix--Continued

96	67	--	70	--	60	--	30	--	40	--	50	--	65	--	35	--	12.5	36	71	47	22	.57	.71	.49	10.3
97	172	--	170	--	180	--	180	--	160	--	173	--	175	--	170	--	10.2	36	73	46	59	.22	.23	.29	13.5
98	257	--	170	--	220	--	270	--	280	--	235	--	195	--	275	--	9.4	39	69	50	83	.33	.28	.47	11.8
99	31	--	20	--	40	--	60	--	80	--	50	--	30	--	70	--	13.2	36	67	48	89	.67	.48	.64	7.0
100	360	--	240	--	340	--	390	--	480	--	363	--	290	--	435	--	10.5	61	93	63	82	.27	.21	.13	39.0
101	238	--	230	--	280	--	300	--	360	--	293	--	255	--	330	--	15.2	75	110	71	66	.65	.63	.24	22.3
102	98	--	100	--	80	--	90	--	120	--	98	--	90	--	105	--	19.8	89	107	85	40	1.34	1.24	.30	17.3
103	150	--	140	--	160	--	150	--	120	--	143	--	150	--	135	--	26.3	86	118	79	45	1.04	1.66	.22	20.8
104	202	--	180	--	240	--	270	--	240	--	233	--	210	--	255	--	16.0	74	112	69	69	.72	.66	.23	28.5
105	243	--	230	--	260	--	240	--	240	--	243	--	245	--	240	--	19.2	81	121	74	56	1.11	1.11	.41	14.2
107	132	--	120	--	140	--	180	--	160	--	150	--	130	--	170	--	14.1	70	77	82	84	.90	.94	.40	10.8
108	138	--	100	--	100	--	150	--	200	--	138	--	100	--	175	--	19.0	72	80	82	43	1.47	1.36	.50	10.3
109	158	--	110	--	140	--	180	--	200	--	158	--	125	--	190	--	19.9	79	82	89	34	1.72	1.74	.45	10.0
110	263	--	230	--	300	--	240	--	280	--	263	--	265	--	260	--	26.5	98	160	77	68	.86	.84	.14	41.3
111	200	--	180	--	220	--	210	--	160	--	193	--	200	--	185	--	29.1	115	177	86	50	.98	.97	.13	39.5
112	50	--	60	--	40	--	30	--	40	--	43	--	50	--	35	--	24.8	84	70	104	22	2.44	2.56	.50	9.3
113	243	--	210	--	320	--	390	--	360	--	320	--	265	--	375	--	16.4	83	169	64	72	.62	.58	.21	36.3
114	276	--	260	--	280	--	330	--	360	--	308	--	270	--	345	--	13.0	59	101	59	85	.44	.42	.29	20.0
115	224	--	190	--	280	--	300	--	360	--	283	--	235	--	330	--	14.0	64	92	67	82	.48	.59	.20	24.3
116	213	--	160	--	240	--	210	--	240	--	213	--	200	--	225	--	17.9	70	86	77	73	.75	.75	.27	21.3
117	260	--	260	--	260	--	210	--	240	--	243	--	260	--	225	--	26.8	114	301	77	55	.00	.35	.04	55.0
118	295	--	210	--	240	--	330	--	400	--	295	--	225	--	365	--	27.0	110	279	72	66	.60	.80	.16	35.0
119	398	--	450	--	400	--	360	--	320	--	383	--	425	--	340	--	11.3	64	57	90	93	.59	.56	.35	14.3
120	300	--	210	--	340	--	390	--	480	--	355	--	275	--	435	--	12.1	67	69	84	90	.44	.45	.19	20.0
121	247	--	230	--	280	--	330	--	320	--	290	--	255	--	325	--	15.3	88	70	109	82	1.21	1.16	.38	12.3
122	247	--	230	--	280	--	330	--	320	--	290	--	255	--	325	--	15.3	88	70	109	76	1.21	1.19	.38	13.5
123	193	--	240	--	160	--	210	--	200	--	203	--	200	--	205	--	8.4	42	50	69	91	.18	.17	.20	21.0
124	124	--	170	--	200	--	120	--	80	--	143	--	185	--	100	--	9.5	52	50	78	88	.43	.37	.31	15.0
125	126	--	140	--	160	--	140	--	50	--	123	--	150	--	95	--	10.7	55	51	79	67	.69	.56	.42	11.5
126	112	--	120	--	120	--	90	--	120	--	113	--	120	--	105	--	10.1	52	52	80	75	.33	.32	.25	18.3
127	189	--	150	--	200	--	240	--	240	--	208	--	175	--	240	--	12.0	55	58	78	54	.57	.55	.34	13.5
128	320	--	240	--	340	--	360	--	320	--	315	--	290	--	340	--	8.0	48	50	77	91	.22	.18	.23	20.8
129	400	--	370	--	440	--	450	--	400	--	415	--	405	--	425	--	7.5	45	50	71	92	.18	.16	.21	21.5
130	234	--	250	--	220	--	210	--	280	--	240	--	235	--	245	--	12.3	57	37	107	97	.86	.76	.49	9.5
131	165	--	150	--	200	--	210	--	240	--	200	--	175	--	225	--	14.7	64	38	115	92	1.16	1.21	.44	9.8
132	277	--	290	--	260	--	270	--	280	--	275	--	275	--	275	--	12.7	61	38	110	96	.75	.86	.35	9.8
133	103	38	70	40	100	40	120	30	120	40	103	38	85	40	120	35	26.5	86	112	81	40	1.24	1.18	.19	22.8
134	250	30	150	30	220	20	270	30	360	40	250	30	185	25	315	35	24.4	88	176	67	60	1.33	1.12	.26	23.0
135	258	--	200	--	280	--	270	--	280	--	258	--	240	--	275	--	24.0	109	85	120	82	2.36	2.38	.41	14.5
136	223	--	170	--	200	--	240	--	280	--	223	--	185	--	260	--	25.4	91	81	102	87	2.43	2.39	.42	13.5

Appendix--Continued

137	233	--	210	--	240	--	240	--	240	--	233	--	225	--	240	--	10.3	55	55	80	70	.48	.46	.38	13.3
138	191	--	160	--	180	--	210	--	280	--	208	--	170	--	245	--	11.5	60	50	93	76	.57	.58	.35	11.5
139	217	64	200	60	260	100	210	60	200	40	218	65	230	80	205	50	10.2	50	78	59	55	.26	.28	.31	17.5
140	70	25	80	10	60	20	60	30	80	40	70	25	70	15	70	35	17.6	62	106	60	18	.87	.83	.35	12.8
141	213	--	230	--	200	--	180	--	240	--	213	--	215	--	210	--	18.1	88	71	108	72	1.40	1.40	.36	11.8
142	140	--	120	--	160	--	120	--	120	--	130	--	140	--	20	--	16.6	86	66	110	71	1.49	1.44	.45	10.3
143	251	--	210	--	240	--	330	--	320	--	275	--	225	--	325	--	11.9	79	57	110	84	.69	.73	.32	13.5
144	300	--	290	--	300	--	330	--	280	--	300	--	295	--	305	--	15.1	65	57	91	48	1.06	1.13	.45	9.5
145	428	--	310	--	460	--	420	--	480	--	418	--	385	--	450	--	10.0	65	55	95	80	.33	.24	.18	16.0
146	298	--	200	--	340	--	330	--	320	--	298	--	270	--	325	--	17.5	75	55	108	41	1.81	1.83	.65	7.3
147	213	25	180	10	220	20	210	30	240	40	213	25	200	15	225	35	18.0	100	89	107	78	1.14	1.20	.27	15.8
148	243	25	180	10	240	20	270	30	280	40	243	25	210	15	275	35	18.2	114	88	122	76	1.32	1.46	.27	18.5
149	187	--	200	--	180	--	150	--	200	--	243	--	190	--	175	--	15.9	88	55	123	72	1.45	1.42	.44	10.0
150	159	--	150	--	200	--	210	--	240	--	200	--	175	--	225	--	16.3	88	57	121	79	1.63	1.53	.48	9.8
151	95	--	90	--	100	--	90	--	80	--	90	--	95	--	85	--	19.2	90	58	122	44	2.38	2.37	.72	6.8
152	353	--	320	--	320	--	330	--	440	--	353	--	320	--	385	--	10.4	71	56	101	91	.46	.43	.24	18.0
153	355	--	340	--	380	--	360	--	320	--	350	--	360	--	340	--	12.1	75	53	110	96	.66	.69	.32	13.5
154	208	--	160	--	180	--	210	--	280	--	208	--	170	--	245	--	20.5	79	68	100	75	1.61	1.70	.35	11.5
155	155	--	150	--	160	--	120	--	120	--	138	--	155	--	120	--	18.8	86	66	110	81	1.46	1.72	.42	9.6
156	180	--	120	--	180	--	180	--	240	--	180	--	150	--	210	--	38.8	147	155	115	35	2.92	2.72	.35	13.8
157	352	--	300	--	400	--	420	--	480	--	400	--	350	--	450	--	12.9	62	74	77	92	.34	.38	.19	21.5
158	323	--	240	--	360	--	330	--	360	--	323	--	300	--	345	--	17.2	69	69	87	56	1.37	1.34	.56	8.8
159	270	--	280	--	300	--	390	--	440	--	353	--	290	--	415	--	16.0	72	71	88	83	.90	.76	.25	19.3
160	369	--	280	--	380	--	450	--	400	--	378	--	330	--	425	--	10.9	70	70	87	81	.45	.48	.23	19.9
161	377	--	330	--	420	--	420	--	360	--	383	--	375	--	390	--	12.2	64	73	77	85	.38	.47	.19	16.5
162	145	--	140	--	160	--	120	--	160	--	145	--	150	--	140	--	18.0	80	61	108	60	1.60	1.49	.44	10.4
163	253	--	210	--	280	--	240	--	280	--	253	--	245	--	260	--	18.3	80	64	105	71	1.61	1.42	.43	11.3
164	246	--	240	--	240	--	330	--	320	--	283	--	240	--	325	--	14.0	74	73	89	89	.77	.72	.29	15.3
165	233	--	180	--	240	--	270	--	240	--	233	--	210	--	255	--	18.4	79	71	97	85	1.37	1.21	.33	14.3
166	320	--	270	--	360	--	330	--	320	--	320	--	315	--	325	--	19.4	76	70	94	89	1.70	1.37	.43	12.4
167	285	--	290	--	280	--	270	--	240	--	270	--	285	--	255	--	13.1	70	67	89	86	.66	.64	.27	15.5
168	312	--	320	--	320	--	300	--	360	--	325	--	320	--	330	--	15.3	68	71	83	83	.85	.82	.30	14.0
169	341	--	310	--	400	--	330	--	320	--	340	--	295	--	325	--	11.1	73	67	93	90	.81	.60	.24	17.1
170	316	--	270	--	380	--	330	--	320	--	325	--	325	--	325	--	13.2	73	70	90	88	.83	.74	.34	13.4
171	215	--	180	--	200	--	240	--	240	--	215	--	190	--	240	--	16.9	79	114	74	58	.74	.83	.28	13.5
172	149	--	140	--	180	--	270	--	240	--	208	--	160	--	255	--	16.4	78	148	64	41	.71	.83	.24	14.0
173	153	--	120	--	140	--	150	--	200	--	153	--	130	--	175	--	21.5	84	126	75	50	1.20	1.30	.35	11.9
174	153	--	90	--	140	--	180	--	200	--	153	--	115	--	190	--	18.5	78	152	64	34	.92	.98	.34	11.6
175	178	--	170	--	160	--	180	--	200	--	178	--	165	--	190	--	16.8	71	87	77	53	.81	1.01	.36	11.6
176	202	--	180	--	260	--	210	--	280	--	233	--	220	--	245	--	14.5	69	85	76	59	.59	.58	.21	18.0

Appendix--Continued

177	68	--	50	--	80	--	60	--	80	--	68	--	65	--	70	--	17.7	74	88	80	41	1.19	1.25	.45	10.0
178	299	--	270	--	320	--	450	--	520	--	390	--	295	--	485	--	13.6	69	78	80	66	.75	.72	.36	13.0
179	104	--	90	--	140	--	150	--	160	--	135	--	115	--	155	--	15.9	53	69	67	46	.92	.78	.46	11.0
180	186	--	190	--	160	--	150	--	120	--	155	--	175	--	135	--	15.7	74	100	74	52	.85	.78	.37	13.5
181	251	--	220	--	340	--	300	--	360	--	305	--	280	--	330	--	15.9	62	113	58	44	.63	.55	.26	16.2
182	203	--	190	--	220	--	210	--	200	--	205	--	205	--	205	--	12.7	53	120	48	44	.39	.35	.21	23.9
183	224	--	200	--	240	--	300	--	280	--	255	--	220	--	290	--	13.6	57	119	52	68	.38	.38	.27	19.0
184	302	--	280	--	280	--	390	--	280	--	308	--	280	--	335	--	11.7	54	122	49	72	.25	.23	.17	36.9
185	143	--	150	--	160	--	180	--	240	--	183	--	155	--	210	--	15.4	53	112	50	62	.45	.37	.23	24.0
186	262	--	230	--	300	--	390	--	330	--	313	--	265	--	360	--	15.0	64	81	72	57	.73	.66	.31	14.6
187	308	--	230	--	360	--	450	--	440	--	370	--	295	--	445	--	12.9	62	79	71	75	.47	.46	.21	20.8
188	290	--	280	--	300	--	300	--	280	--	290	--	290	--	290	--	15.1	61	81	69	73	.58	.60	.22	21.3
190	286	--	230	--	360	--	360	--	360	--	328	--	295	--	360	--	13.8	66	75	79	88	.70	.63	.30	15.8
191	175	--	130	--	160	--	210	--	200	--	175	--	145	--	205	--	22.1	80	115	74	44	.88	.88	.14	34.8
192	165	--	120	--	160	--	180	--	200	--	165	--	140	--	190	--	21.5	87	119	79	51	1.13	.86	.18	26.5
193	173	--	150	--	160	--	180	--	200	--	173	--	155	--	190	--	22.5	85	122	77	51	.81	.90	.22	28.0
194	145	--	130	--	160	--	180	--	120	--	148	--	145	--	150	--	19.6	81	119	74	58	.86	.71	.18	33.0
195	286	--	220	--	300	--	390	--	320	--	308	--	260	--	355	--	11.8	60	81	68	82	.36	.29	.13	26.3
196	146	--	140	--	200	--	210	--	280	--	208	--	170	--	245	--	16.0	69	82	78	73	.58	.57	.16	21.0
197	170	--	150	--	180	--	210	--	160	--	175	--	165	--	185	--	12.5	54	73	66	77	.40	.37	.22	19.8
198	146	--	150	--	120	--	150	--	200	--	155	--	135	--	175	--	11.7	43	68	56	74	.21	.22	.13	29.0
199	114	--	160	--	120	--	90	--	120	--	123	--	140	--	105	--	9.4	39	78	47	68	.12	.12	.10	37.0
200	131	--	150	--	140	--	90	--	80	--	115	--	145	--	85	--	12.0	38	73	48	66	.16	.20	.10	27.8
201	198	--	170	--	220	--	240	--	160	--	198	--	195	--	200	--	11.0	39	71	50	71	.15	.14	.10	33.5
202	138	--	150	--	100	--	150	--	160	--	140	--	125	--	155	--	11.0	45	74	55	61	.18	.20	.19	21.8
203	60	--	60	--	60	--	60	--	40	--	55	--	60	--	50	--	21.3	70	154	57	38	.57	.54	.13	24.3
204	135	--	150	--	100	--	150	--	120	--	130	--	125	--	135	--	14.7	57	57	81	66	.54	.60	.15	16.3
205	108	--	130	--	80	--	90	--	80	--	95	--	105	--	85	--	13.3	48	57	70	46	.67	.58	.37	14.0
206	198	--	190	--	220	--	180	--	200	--	198	--	205	--	190	--	11.0	48	68	62	51	.23	.23	.15	23.0
207	211	--	200	--	220	--	210	--	240	--	218	--	205	--	225	--	12.1	49	65	65	57	.46	.40	.29	15.5
208	145	--	150	--	140	--	98	--	80	--	117	--	145	--	89	--	19.5	80	97	81	74	.76	.68	.10	32.8
209	188	--	150	--	220	--	240	--	240	--	213	--	185	--	240	--	12.8	46	57	67	63	.48	.54	.21	19.5
210	88	--	140	--	40	--	30	--	40	--	63	--	90	--	35	--	12.7	48	56	71	41	.54	.52	.35	14.0
211	170	--	180	--	180	--	120	--	160	--	160	--	180	--	140	--	12.7	61	66	79	53	.48	.46	.24	18.5
212	86	--	140	--	120	--	60	--	40	--	90	--	130	--	50	--	10.2	45	63	61	61	.21	.22	.20	21.3
213	217	--	200	--	240	--	210	--	200	--	213	--	220	--	205	--	16.3	60	60	83	63	.74	.78	.24	16.8
214	200	--	220	--	200	--	240	--	200	--	215	--	205	--	220	--	7.5	38	77	46	65	.10	.09	.15	31.5
215	200	--	220	--	320	--	300	--	200	--	235	--	220	--	250	--	7.5	40	79	47	60	.08	.04	.09	38.3
216	180	--	220	--	160	--	180	--	120	--	170	--	190	--	150	--	11.3	44	78	52	63	.21	.19	.14	26.0
217	280	--	320	--	360	--	300	--	280	--	315	--	340	--	290	--	6.9	41	73	51	66	.07	.08	.10	34.5

Appendix--Continued

218	120	--	150	--	120	--	150	--	120	--	135	--	135	--	135	--	8.2	39	77	47	68	.09	.08	.08	34.8
219	280	--	200	--	220	--	300	--	280	--	250	--	205	--	290	--	7.7	36	74	44	65	.08	.09	.10	35.5
220	173	--	140	--	180	--	210	--	160	--	173	--	160	--	185	--	21.0	107	107	103	82	1.24	1.23	.20	24.0
221	158	--	140	--	200	--	120	--	160	--	155	--	170	--	140	--	15.4	99	80	112	84	1.09	1.11	.28	14.5
222	151	--	120	--	160	--	210	--	200	--	173	--	140	--	205	--	12.4	63	55	91	62	.74	.65	.41	11.1
223	165	--	130	--	200	--	270	--	240	--	210	--	165	--	255	--	14.1	59	52	89	84	.99	.97	.44	9.3
224	114	--	110	--	100	--	150	--	80	--	110	--	105	--	115	--	13.5	67	47	107	78	1.20	1.19	.67	7.3
225	215	35	250	30	180	40	90	30	80	40	150	30	215	35	85	35	20.3	82	96	84	81	.85	1.03	.20	17.5
226	185	40	210	60	160	20	120	30	120	40	153	38	185	40	120	35	23.8	100	94	104	82	1.58	1.65	.24	15.5
227	140	40	180	40	100	40	90	60	120	80	123	55	140	40	105	70	21.1	100	93	104	70	1.24	1.21	.22	24.8
228	72	--	70	--	60	--	90	--	120	--	85	--	65	--	105	--	12.4	52	61	71	56	.78	.44	.55	8.6
229	74	--	60	--	80	--	90	--	80	--	78	--	70	--	85	--	11.5	57	67	74	32	.86	.77	.62	6.3
230	136	--	80	--	120	--	120	--	160	--	120	--	100	--	140	--	9.3	43	68	56	50	.29	.29	.40	10.5
231	107	--	90	--	100	--	120	--	160	--	118	--	95	--	140	--	11.8	49	65	65	38	.57	.55	.47	8.0
232	98	--	70	--	80	--	90	--	120	--	90	--	75	--	105	--	9.5	43	65	56	45	.30	.25	.28	18.3
233	81	--	80	--	80	--	120	--	120	--	100	--	80	--	120	--	14.3	70	107	67	49	.74	.74	.35	13.9
234	140	100	160	100	120	100	150	120	120	80	138	100	140	100	135	100	18.6	82	116	76	81	.72	.73	.20	22.3
235	33	--	20	--	40	--	30	--	40	--	33	--	30	--	35	--	22.7	86	101	86	51	.82	.98	.16	24.6
236	48	33	40	30	60	40	60	30	80	40	60	35	50	35	70	35	13.5	50	84	56	14	.38	.39	.20	16.3
237	43	--	30	--	40	--	60	--	40	--	43	--	35	--	50	--	27.1	129	238	88	15	1.10	1.28	.19	25.8
238	123	85	80	50	100	80	150	90	160	120	123	85	90	65	155	105	26.0	102	141	85	11	1.36	1.50	.22	22.9
239	100	70	100	60	100	80	60	30	80	40	85	53	100	70	70	35	34.2	128	186	93	60	1.98	1.64	.19	15.4
240	70	70	60	60	80	80	60	60	80	80	70	70	70	70	70	70	28.7	90	159	71	27	1.40	1.35	.21	27.4
241	30	30	30	30	20	20	30	30	40	40	30	30	25	25	35	35	27.5	91	134	78	22	1.30	1.61	.30	23.0
242	115	115	80	80	100	100	120	120	160	160	115	115	90	90	140	140	23.4	85	162	67	43	.73	.76	.19	29.5
243	40	40	40	40	40	40	30	30	40	40	38	38	40	40	35	35	24.4	70	146	57	16	1.43	1.17	.24	18.8
244	103	50	120	20	80	40	90	60	120	80	103	50	100	30	105	70	26.8	114	333	76	65	.80	.60	.14	59.5
245	58	58	60	60	60	60	60	60	80	80	65	65	60	60	70	70	14.2	52	42	92	34	1.00	.99	.47	8.5
246	140	140	100	100	140	140	180	180	200	200	155	155	120	120	190	190	11.5	49	57	71	56	.56	.44	.39	12.3
247	128	128	120	120	140	140	120	120	120	120	125	125	130	130	120	120	15.6	58	46	97	52	1.21	1.23	.58	7.3
248	139	139	110	110	160	160	180	180	80	80	133	133	135	135	130	130	12.9	51	51	79	47	.77	.68	.41	10.7
249	109	109	40	40	80	80	120	120	160	160	100	100	60	60	140	140	10.0	50	42	88	41	.43	.44	.37	10.8
250	115	115	60	60	80	80	120	120	160	160	105	105	70	70	140	140	9.9	49	47	81	40	.42	.40	.41	11.4
251	18	18	20	20	20	20	30	30	40	40	28	28	20	20	35	35	15.5	60	87	64	12	.88	.90	.41	10.6
252	200	200	110	110	160	160	210	210	200	200	170	170	135	135	205	205	8.0	46	45	79	69	.22	.22	.23	15.3
253	119	119	110	110	100	100	150	150	200	200	140	140	205	205	175	175	12.2	52	42	92	63	.66	.66	.41	10.9
254	172	172	90	90	160	160	210	210	200	200	165	165	125	125	205	205	10.1	38	48	66	74	.22	.26	.29	12.5
255	79	79	100	100	140	140	60	60	80	80	95	95	120	120	70	70	8.6	46	46	79	86	.27	.28	.33	11.8
256	163	72	330	190	300	160	210	90	160	80	250	130	315	175	185	105	8.3	54	53	83	99	.18	.19	.22	18.1
257	204	163	240	130	280	200	240	180	160	140	230	163	260	165	200	160	8.9	52	57	75	93	.24	.22	.21	19.8

Appendix--Continued

258	172	159	200	130	220	180	150	150	160	160	183	155	210	155	155	155	9.4	50	50	79	94	.29	.27	.22	18.0
259	117	102	150	140	140	120	90	60	80	80	115	100	145	130	85	70	10.6	60	52	90	68	.50	.47	.29	12.5
260	168	130	180	120	140	120	150	120	200	160	168	130	160	120	175	140	10.4	54	57	77	70	.42	.39	.28	13.8
261	53	43	70	50	40	40	30	30	40	40	45	40	55	45	35	35	12.8	59	68	75	83	.63	.62	.36	12.0
262	73	70	80	60	80	60	60	60	80	80	75	65	80	60	70	70	9.0	46	56	69	66	.28	.27	.36	12.3
263	115	91	90	80	100	80	120	90	160	120	118	93	95	80	140	105	10.7	58	48	93	65	.50	.49	.32	13.5
264	51	51	60	60	40	40	60	60	40	40	50	50	50	50	50	50	11.2	52	49	83	71	.48	.48	.35	11.9
265	218	125	230	130	240	140	240	150	160	80	218	125	235	135	200	115	10.5	51	54	76	76	.39	.40	.31	12.8
266	205	145	240	180	180	120	120	60	120	80	165	110	210	150	120	70	13.3	69	70	86	73	.66	.68	.31	12.5
267	140	84	130	80	140	80	150	90	200	120	155	93	135	80	175	105	12.2	52	57	75	87	.51	.49	.31	12.5
268	102	80	140	100	60	60	30	30	40	40	68	58	100	80	35	35	13.7	59	52	89	65	.80	.63	.36	11.2
269	179	148	220	130	260	180	210	180	160	120	213	153	240	155	185	150	8.3	57	59	80	82	.21	.21	.23	17.9
270	111	90	80	70	100	80	120	90	160	120	115	50	90	75	140	105	10.8	54	56	79	63	.33	.36	.19	16.1
271	86	77	90	80	120	100	60	60	40	40	78	70	105	90	50	50	11.4	45	53	70	53	.46	.47	.34	9.6
272	76	67	80	70	80	60	60	60	80	80	75	68	80	65	70	70	11.0	41	53	66	45	.36	.40	.42	9.1
273	267	136	130	90	180	100	240	120	320	160	218	118	155	95	280	140	9.1	49	51	76	51	.29	.28	.23	12.2
274	161	163	110	80	120	80	150	150	160	160	135	118	115	80	155	155	8.3	44	53	69	70	.18	.19	.18	13.5
275	111	111	60	60	80	80	120	120	120	120	95	95	70	70	120	120	9.2	50	53	76	55	.27	.28	.23	13.2
276	84	84	80	80	80	80	90	90	40	40	73	73	80	80	65	65	13.5	53	53	80	42	.93	.85	.62	7.6
277	151	192	180	130	240	180	180	180	160	160	190	163	210	155	170	170	6.9	38	53	61	76	.13	.14	.26	12.8
278	240	240	260	240	280	260	210	180	240	240	248	230	270	250	225	210	5.9	32	55	51	84	.30	.21	.12	21.6
279	200	200	210	190	200	180	240	240	200	200	213	203	205	185	220	220	4.8	33	48	59	80	.08	.06	.18	19.4
280	80	80	130	100	120	100	90	90	80	80	105	93	125	100	85	85	7.8	41	52	66	76	.16	.18	.27	12.9
281	43	43	30	30	40	40	60	60	40	40	43	43	35	35	50	50	10.1	35	55	55	39	.29	.31	.42	8.7
282	200	200	150	120	200	140	240	210	200	200	198	168	175	130	220	205	7.8	49	61	67	83	.20	.17	.27	21.9
283	200	160	210	150	220	120	150	120	200	160	195	138	205	135	175	140	7.0	44	61	61	90	.15	.12	.19	26.3
284	120	80	160	130	220	200	150	90	120	80	163	125	190	165	135	85	7.0	43	60	61	89	.11	.11	.13	28.1
285	240	200	200	150	220	200	240	210	240	200	225	190	210	175	240	205	6.5	42	59	61	88	.06	.08	.06	31.9
286	201	169	150	110	220	180	210	150	200	200	195	160	185	145	205	175	9.7	48	59	69	80	.31	.28	.29	15.2
287	56	30	50	30	80	40	90	60	120	80	85	53	65	35	105	70	15.2	64	56	91	48	.83	.90	.35	13.5
288	74	74	90	90	100	100	60	60	80	80	83	83	95	95	70	70	8.5	42	55	64	72	.23	.20	.30	15.2
289	84	72	80	70	100	80	60	60	80	80	80	73	90	75	70	70	13.6	58	56	84	69	.79	.77	.45	10.2
290	127	113	130	110	140	140	120	120	160	160	138	133	135	125	140	140	10.4	82	86	89	75	.84	.85	.20	24.0
291	140	114	140	100	120	100	150	120	160	160	143	120	130	100	155	140	11.1	65	73	79	76	.36	.39	.21	24.8
292	119	112	130	120	100	100	120	120	120	120	118	115	115	110	120	120	15.0	76	81	86	80	.57	.51	.15	29.1
293	102	71	120	70	80	80	60	60	80	80	85	73	100	75	70	70	14.6	64	100	64	80	.32	.36	.15	31.1
294	220	148	200	140	240	160	240	150	280	200	240	163	220	150	260	175	12.8	65	102	64	74	.34	.30	.15	36.0
295	132	76	180	90	160	80	90	60	120	80	138	78	170	85	105	70	10.0	57	80	66	77	.26	.27	.22	21.6
296	135	135	130	130	100	100	150	150	160	160	135	135	115	115	155	155	16.9	82	84	91	70	1.24	1.34	.38	10.2
297	149	149	130	130	160	160	180	180	200	200	168	168	145	145	190	190	12.7	80	88	83	70	.64	.63	.23	16.1

Appendix--Continued

298	122	108	110	100	120	100	150	120	80	40	115	90	115	100	115	80	14.2	75	84	83	73	.78	.71	.24	14.2
299	132	132	130	130	120	120	90	90	80	80	105	105	125	125	85	85	16.5	91	92	96	74	1.17	1.17	.33	11.8
300	121	121	110	110	140	140	120	120	120	120	123	123	125	125	120	120	14.7	89	86	97	63	.63	.81	.22	14.9
301	139	126	140	130	140	120	150	120	160	120	148	123	140	125	155	120	14.5	84	88	90	77	.46	.73	.26	12.7
302	172	172	170	170	160	160	180	180	200	200	178	178	165	165	190	190	11.8	54	71	67	82	.41	.36	.23	20.4
303	268	176	210	120	260	180	300	180	320	240	273	180	235	150	315	120	10.7	56	69	71	80	.26	.32	.17	22.6
304	268	267	250	190	360	280	300	240	320	320	273	258	305	235	310	280	9.9	54	73	66	86	.24	.22	.15	28.7
305	207	159	260	180	260	200	150	120	120	120	198	155	260	190	135	120	10.8	65	65	85	90	.30	.35	.35	22.0
306	228	168	230	180	200	140	270	180	280	240	245	185	315	160	325	210	12.6	66	67	84	87	.62	.60	.30	15.5
307	305	221	250	160	240	160	300	210	360	280	288	203	245	160	330	245	9.6	57	73	69	90	.21	.23	.12	30.6
308	130	130	120	120	140	140	120	120	120	120	125	125	130	130	120	120	22.9	77	133	66	54	1.10	1.01	.23	22.5
309	140	140	110	110	200	200	210	210	240	240	190	190	155	155	225	225	14.7	73	87	79	72	.62	.67	.22	18.4
310	221	183	200	130	200	160	210	180	240	200	213	168	200	145	225	190	9.3	50	61	69	84	.13	.18	.11	26.0
311	320	200	180	130	240	140	330	210	320	200	268	170	210	135	325	205	8.2	48	59	69	80	.14	.15	.16	26.7
312	40	40	140	110	60	60	60	60	40	40	75	68	100	85	50	50	7.9	36	52	60	80	.12	.14	.17	20.2
313	151	119	170	150	220	200	150	120	120	80	165	138	195	175	135	100	9.3	36	113	34	73	.05	.05	.10	47.5
314	170	167	160	140	180	180	180	180	160	160	170	165	170	160	170	170	9.8	41	113	38	64	.10	.08	.08	46.0
315	169	145	170	160	160	140	150	120	200	160	170	145	165	150	175	140	10.8	38	113	35	70	.14	.13	.21	48.0
316	95	95	70	70	100	100	120	120	160	160	113	113	85	85	140	140	12.0	49	114	45	61	.24	.25	.19	25.8
317	172	167	130	110	200	180	180	180	160	160	168	158	165	145	170	170	9.3	40	115	37	58	.12	.09	.12	39.3
318	147	109	150	110	140	100	150	120	160	120	150	113	145	105	155	120	12.1	54	62	74	85	.56	.60	.39	10.8
319	101	58	160	110	140	120	90	30	80	40	118	75	150	115	85	35	9.4	50	65	66	80	.30	.27	.31	16.3
320	110	103	150	130	100	100	90	90	80	80	105	100	125	115	85	85	10.9	54	56	79	80	.51	.49	.41	13.2
321	186	96	180	100	200	100	180	60	200	80	190	85	190	100	190	70	13.7	61	66	79	77	.76	.79	.41	11.1
322	153	153	170	130	140	120	150	150	160	160	155	140	155	125	155	155	8.7	47	51	75	82	.20	.22	.26	17.1
323	158	158	80	80	120	120	190	190	240	240	158	158	100	100	215	215	27.3	103	129	89	66	1.62	1.78	.24	21.1
324	213	188	130	120	200	180	240	210	280	240	213	188	165	150	260	225	24.5	107	135	91	53	1.78	1.74	.29	15.3
325	125	120	100	80	120	120	120	120	160	160	125	120	110	100	140	140	29.1	97	112	91	65	1.44	1.80	.22	21.5
326	160	155	120	110	200	200	120	120	80	80	130	128	160	155	100	100	24.9	106	115	97	52	1.72	1.62	.23	24.7
327	205	150	170	120	240	180	210	150	160	80	195	133	205	150	185	115	26.2	106	145	87	55	1.76	1.90	.30	17.2
328	84	83	150	140	140	140	60	60	40	40	98	95	145	140	50	50	9.8	40	73	50	73	.19	.21	.22	23.8
329	179	147	160	140	200	160	210	150	120	120	173	143	180	150	165	135	11.9	49	77	58	74	.38	.32	.19	22.6
330	126	120	130	120	120	120	120	120	120	120	123	120	125	120	120	120	13.7	56	68	71	63	.41	.42	.15	26.3
331	149	133	120	110	180	160	210	180	280	240	198	173	150	135	245	210	13.3	54	66	70	61	.45	.53	.22	17.8
332	150	128	130	110	160	140	210	180	240	240	185	168	145	125	225	210	13.1	55	68	70	65	.45	.48	.20	18.4
333	155	148	120	100	140	140	180	180	240	240	170	165	130	120	210	210	11.3	42	72	52	75	.28	.27	.26	19.0
334	91	78	90	80	100	80	60	60	80	80	83	75	95	80	70	70	14.9	50	65	67	47	.67	.78	.42	10.1
335	123	123	110	110	140	140	120	120	120	120	123	123	225	225	120	120	17.8	55	86	60	66	.58	.69	.21	18.2
336	154	110	160	120	160	100	210	150	240	160	193	133	160	110	225	155	15.2	52	141	44	44	.40	.38	.20	21.8
337	171	128	160	120	260	200	330	270	400	320	288	228	210	160	365	295	16.3	61	135	52	56	.54	.45	.18	30.6

Appendix--Continued

338	222	139	210	140	280	180	240	150	320	240	263	178	245	160	280	195	15.8	65	133	56	58	.46	.51	.22	20.5
339	142	129	120	110	180	160	180	180	200	200	170	163	150	135	190	190	14.2	60	129	52	64	.36	.33	.16	30.7
340	272	251	210	180	260	220	240	210	320	320	258	233	235	200	280	265	9.6	54	142	46	72	.13	.16	.11	51.8
341	236	205	180	150	240	220	210	180	280	240	228	198	210	185	245	210	9.8	56	134	48	60	.16	.17	.15	52.4
342	133	133	100	100	180	180	180	180	160	160	155	155	140	140	170	170	14.7	56	93	58	55	.36	.44	.15	24.9
343	253	240	200	160	260	240	300	300	240	240	250	235	230	200	270	270	10.1	45	99	45	74	.16	.13	.14	30.1
344	216	181	170	140	220	180	210	180	280	240	220	185	195	160	245	160	10.7	42	107	41	72	.13	.11	.13	39.2
345	160	132	200	170	140	120	120	90	160	120	155	125	170	145	140	105	11.3	44	108	42	65	.16	.16	.14	40.4
346	212	187	240	220	220	180	180	150	160	160	200	178	230	200	170	155	11.5	44	113	41	66	.12	.12	.10	44.5
347	201	171	150	120	200	180	210	180	240	200	200	170	175	150	225	190	10.4	40	107	39	70	.10	.10	.11	39.0
348	256	226	270	230	300	240	270	240	200	200	260	228	285	235	235	220	10.1	42	110	40	79	.08	.11	.12	43.8
349	62	52	60	50	60	60	90	90	80	80	73	70	60	55	85	85	14.5	37	102	37	31	.26	.25	.19	27.1
350	54	42	50	40	60	40	90	60	80	40	70	45	55	40	85	50	15.1	42	97	43	51	.33	.38	.18	23.6
351	93	90	100	90	60	60	90	90	120	120	93	90	80	75	105	105	23.3	55	193	44	53	.28	.29	.14	35.3
352	279	0	280	0	260	0	270	0	240	0	263	0	270	0	255	0	16.2	71	60	97	92	1.42	1.36	.53	8.2
353	117	0	110	0	120	0	180	0	200	0	153	0	115	0	190	0	13.8	74	65	97	59	.85	.87	.38	11.6
354	144	124	160	130	120	120	90	90	120	120	123	115	140	125	105	105	16.0	81	58	112	75	1.34	1.35	.46	10.0
355	151	102	160	90	140	120	180	150	200	160	170	130	150	105	190	155	14.3	69	61	94	75	.89	.97	.40	10.5
356	150	100	160	100	140	100	120	120	120	120	135	110	150	100	120	120	17.4	78	55	111	84	1.44	1.79	.46	10.8
357	215	170	190	160	240	180	240	180	160	160	208	170	215	170	200	170	17.5	84	60	113	78	1.36	1.36	.36	12.9
358	133	133	130	130	120	120	120	120	160	160	133	133	225	225	140	140	18.1	84	59	114	70	2.02	1.74	.59	9.0
359	280	210	280	180	280	240	270	270	200	200	258	223	280	210	235	235	22.6	119	67	147	75	2.00	2.58	.37	10.6
360	233	155	230	170	220	140	240	150	240	160	233	155	225	155	240	155	24.8	107	69	130	76	3.02	3.25	.48	8.8
361	320	260	300	220	340	300	240	180	240	200	280	225	320	260	240	190	19.5	107	60	140	73	2.53	2.67	.53	8.1
362	295	205	290	210	300	200	180	150	160	120	233	170	295	205	170	135	20.4	109	69	133	74	2.46	2.66	.48	9.1
363	243	170	210	160	280	180	240	180	240	160	243	170	245	170	245	170	20.9	107	69	130	76	1.76	1.99	.30	12.7
364	258	185	190	150	220	180	300	210	320	200	258	185	205	165	310	205	21.9	115	65	144	76	2.20	1.44	.27	12.8
365	228	120	240	110	200	160	210	90	260	120	228	120	220	135	235	105	16.7	81	67	103	82	1.15	1.16	.29	14.6
366	159	73	140	70	240	120	300	180	360	240	260	153	190	95	330	210	15.7	86	70	107	69	.89	.93	.26	14.7
367	213	188	140	130	220	200	210	180	280	240	213	188	180	115	245	210	20.3	107	146	88	49	1.26	1.31	.29	16.1
368	213	185	200	180	160	140	210	180	280	240	213	185	180	160	245	210	21.8	111	156	88	42	1.57	1.27	.22	24.8
369	155	150	170	150	100	100	150	150	200	200	155	150	135	125	175	175	34.7	142	200	100	54	1.10	1.00	.09	35.0
370	225	190	210	160	240	220	180	180	80	80	178	160	225	190	130	130	46.6	154	250	100	67	.40	.80	.11	39.2
371	78	78	60	60	80	80	90	90	80	80	78	78	70	70	85	85	83.0	176	360	108	38	2.40	2.36	.15	27.2
372	143	138	120	110	160	160	150	150	200	200	158	155	140	135	175	175	12.1	59	46	97	76	.86	.78	.53	8.9
373	144	134	180	160	120	120	90	90	80	80	118	113	150	140	85	85	12.6	60	50	93	79	.76	.77	.46	9.4
374	146	120	160	140	140	120	120	90	160	120	145	118	150	130	140	105	11.0	55	52	84	72	.54	.48	.37	13.5
375	155	152	120	110	140	140	180	180	200	200	160	158	130	125	190	190	10.8	49	48	80	74	.45	.43	.37	13.3
376	82	68	110	80	80	80	30	30	40	40	65	58	95	80	35	35	12.1	58	47	94	69	.69	.71	.42	10.9
377	98	85	90	70	100	80	90	90	120	120	100	90	95	75	105	105	11.1	52	50	81	80	.63	.57	.54	9.4

Appendix--Continued

378	160	113	130	90	200	140	210	120	200	80	185	108	165	115	205	100	14.1	52	52	80	76	1.16	1.02	.75	6.4
379	156	130	110	90	160	140	180	150	200	160	163	135	135	115	190	155	10.9	52	50	81	73	.55	.56	.44	10.9
380	220	197	200	150	240	200	240	180	200	200	220	183	220	175	220	190	8.7	49	52	77	88	.29	.29	.40	11.7
381	171	166	190	150	180	160	180	180	160	160	178	163	185	155	170	170	9.2	46	50	74	92	.36	.33	.43	10.2
382	120	120	250	140	260	120	180	90	120	120	203	118	255	130	150	115	8.0	43	59	69	90	.21	.22	.37	11.9
383	198	144	180	140	200	120	210	150	200	160	198	143	190	130	205	155	10.2	58	61	79	84	.51	.46	.42	11.6
384	261	201	180	120	240	200	270	210	360	280	263	203	210	160	315	245	10.5	60	55	84	88	.60	.52	.34	12.8
385	275	237	180	160	280	240	330	270	360	320	288	248	230	200	345	295	10.9	61	48	97	73	.81	.72	.60	7.7
386	101	101	110	110	80	80	120	120	120	120	108	108	95	95	120	120	13.0	53	52	81	77	.90	.89	.61	7.1
387	97	92	110	100	80	80	90	90	120	120	100	98	95	90	105	105	12.8	57	53	86	72	.84	.80	.54	8.8
388	173	141	150	110	120	100	180	150	240	200	173	140	135	105	210	175	10.4	55	54	81	79	.65	.60	.59	7.9
389	190	162	150	120	180	160	240	210	280	240	213	183	165	140	260	225	11.7	61	52	91	76	.88	.83	.58	7.6
390	138	0	130	0	160	0	150	0	160	0	150	0	145	0	155	0	16.2	61	101	61	--	.73	.72	.38	13.0
391	300	0	290	0	360	0	330	0	400	0	345	0	325	0	365	0	16.4	79	55	113	90	.54	1.00	.51	9.0
392	73	49	60	50	80	40	90	60	120	80	88	58	70	45	105	70	12.6	57	47	93	55	.61	.70	.36	10.0
393	229	155	180	140	160	120	210	150	240	160	198	143	170	130	225	155	8.4	42	64	57	93	.16	.14	.17	31.0
394	166	116	200	120	220	160	210	150	120	80	188	128	210	140	165	115	9.0	46	63	63	84	.25	.24	.30	17.5
395	120	80	210	120	220	160	120	90	120	80	168	113	215	140	120	85	6.6	39	64	54	85	.10	.09	.15	30.7
396	280	120	210	100	260	100	300	120	280	120	263	110	235	100	290	120	6.6	36	67	47	78	.08	.08	.08	37.9
397	120	80	190	110	180	80	180	90	120	80	168	90	185	95	150	85	6.8	35	60	51	78	.11	.10	.18	25.3
398	80	40	110	60	120	80	60	30	80	40	93	53	115	70	70	35	7.2	39	62	55	76	.15	.13	.23	25.5
399	240	240	150	130	200	200	240	240	240	240	208	203	175	165	240	240	8.1	47	72	59	73	.14	.14	.18	30.0
400	129	128	80	70	100	100	120	120	160	160	115	113	90	85	140	140	9.5	50	57	73	66	.33	.30	.31	13.7
401	100	100	80	80	80	80	120	120	120	120	100	100	80	80	120	120	10.4	52	57	75	65	.44	.37	.33	15.0
402	76	76	90	90	80	80	60	60	80	80	78	78	85	85	70	70	10.0	43	71	54	69	.29	.28	.31	16.5
403	83	84	90	80	80	80	90	90	80	80	85	83	70	80	70	70	8.8	46	61	64	77	.29	.26	.35	11.9
404	102	102	110	110	140	140	60	60	80	80	98	98	125	125	70	70	11.0	56	72	69	78	.49	.48	.35	11.5
405	123	123	80	80	100	100	120	120	120	120	105	105	90	90	120	120	8.5	47	66	62	82	.25	.25	.32	11.7
406	160	160	50	50	100	100	120	120	160	160	108	108	75	75	140	140	7.5	47	69	60	69	.17	.19	.26	16.9
407	277	197	210	150	360	240	270	210	360	280	300	220	285	195	315	245	12.1	62	65	81	83	.85	.73	.59	9.2
408	189	152	220	160	170	160	150	120	200	160	185	150	195	160	175	140	11.7	73	63	97	85	.94	.86	.57	9.4
409	184	142	180	130	180	140	180	120	160	80	175	118	180	135	170	100	15.8	71	92	74	59	.60	.60	.22	20.4
410	171	128	150	100	200	180	180	180	160	160	173	155	175	140	170	170	16.4	62	89	66	70	.81	.80	.32	14.6
411	43	28	40	30	60	40	60	60	80	80	60	53	50	35	70	70	16.0	60	144	51	12	.24	.25	.15	40.6
412	84	59	90	70	100	60	120	90	160	120	118	85	95	65	140	105	16.2	62	153	51	30	.26	.30	.11	45.3
413	85	70	60	50	80	60	120	90	80	80	85	70	70	55	100	85	22.7	86	129	75	16	1.61	1.44	.41	12.7
414	103	103	60	60	120	120	150	150	80	80	103	103	90	90	115	115	17.6	82	85	90	27	1.16	1.07	.35	14.7
415	73	68	70	50	80	80	60	60	80	80	73	68	75	65	70	70	21.4	70	128	62	41	.71	.69	.18	32.9
416	100	85	60	50	100	80	120	90	120	120	100	85	80	65	120	105	18.4	74	117	68	28	.68	.64	.23	22.0
417	115	87	70	50	120	100	150	120	120	80	115	87	85	75	135	100	17.0	71	135	61	32	.63	.60	.23	19.3

Appendix--Continued

418	65	50	40	20	80	40	60	60	80	80	65	50	60	30	70	70	23.9	98	122	87	31	1.82	1.50	.31	14.4
419	108	78	70	40	80	60	120	90	160	120	108	78	75	50	140	105	19.0	89	117	82	35	.90	1.00	.27	16.3
420	165	140	170	140	160	140	150	120	120	120	150	130	165	140	135	120	16.6	65	43	109	81	1.54	1.35	.60	7.8
421	143	136	120	100	160	160	150	150	160	160	148	143	140	130	155	155	11.4	58	43	100	79	.88	.76	.61	8.4
422	360	240	190	180	360	240	300	270	360	240	303	233	275	210	330	255	8.0	51	48	83	80	.25	.24	.35	15.0
423	140	140	150	150	160	160	90	90	120	120	130	130	155	155	105	105	12.1	53	45	89	74	.80	.69	.53	9.6
424	360	240	240	180	300	200	330	280	360	240	308	225	270	190	345	260	8.0	56	45	93	83	.34	.32	.47	10.1
425	128	128	100	100	100	100	150	150	160	160	128	128	100	100	155	155	22.2	65	46	104	48	3.21	2.99	.93	4.8
426	104	84	80	60	140	120	180	150	240	200	160	133	110	90	210	175	13.8	47	121	43	36	.35	.31	.23	23.1
427	63	63	70	70	60	60	60	60	80	80	68	68	65	65	70	70	16.2	57	111	54	28	.57	.54	.23	18.5
428	144	144	150	150	120	120	120	120	80	80	118	118	135	135	100	100	14.7	62	40	109	51	1.38	1.23	.60	8.1
429	156	127	150	130	200	160	270	210	320	280	235	195	175	145	295	245	15.5	64	44	106	55	1.24	1.26	.51	9.4
430	69	69	70	70	60	60	90	90	80	80	75	75	65	65	85	85	13.9	62	104	61	49	.40	.47	.21	18.9
431	80	75	80	70	80	80	60	60	40	40	65	63	80	75	50	50	19.3	67	69	84	29	1.17	1.02	.35	11.8
432	120	95	110	90	140	120	180	150	160	160	148	130	125	105	170	155	16.2	64	67	82	25	.81	.78	.29	15.4
433	119	98	90	70	140	120	210	180	280	240	180	153	115	95	245	210	13.3	70	79	81	62	.87	.79	.46	11.6
434	25	25	10	10	20	20	30	30	40	40	25	25	15	15	35	35	20.0	53	75	63	0	1.38	1.23	.49	10.4
435	54	54	50	50	60	60	90	90	80	80	70	70	55	55	85	85	15.1	58	122	52	17	.48	.46	.20	26.3
436	50	35	40	30	60	40	30	30	40	40	43	35	50	35	35	35	20.7	69	117	64	23	.73	.81	.24	18.9
437	28	28	20	20	20	20	30	30	40	40	28	28	20	20	35	35	20.0	82	62	109	10	2.02	1.76	.47	10.6
438	195	172	180	160	200	180	240	210	200	200	205	188	190	170	220	205	13.6	62	72	76	80	.61	.59	.30	20.2
439	190	163	120	100	160	140	240	210	240	200	190	163	140	120	240	205	19.7	71	70	88	56	1.31	1.22	.32	15.3
440	221	167	280	220	180	100	150	150	120	120	183	148	230	160	135	135	12.5	54	53	81	83	.68	.68	.47	10.3
441	164	150	160	140	180	180	180	180	200	200	180	175	170	160	190	190	15.5	62	52	93	77	1.36	1.20	.55	8.8
442	173	168	120	100	160	160	210	210	200	200	173	168	140	130	205	205	17.7	56	53	84	63	1.58	1.46	.72	6.7
443	201	174	150	140	140	120	210	180	280	240	195	170	145	130	245	210	10.2	51	51	79	74	.30	.30	.21	18.9
444	125	116	100	80	120	120	180	180	160	160	140	135	110	100	170	170	12.1	62	49	97	72	.89	.81	.53	6.7
446	244	162	190	110	260	160	300	240	280	200	258	178	225	135	290	220	11.5	62	68	79	71	.68	.54	.35	13.9
447	176	146	180	150	180	140	150	150	160	160	168	150	180	145	155	155	13.3	71	74	86	81	.66	.63	.30	18.8
448	149	84	180	80	120	80	120	90	160	120	145	93	150	80	140	105	12.2	73	75	87	84	.60	.54	.29	22.9
449	153	133	180	160	120	100	150	120	200	160	163	135	150	130	175	140	13.5	73	75	87	90	.69	.64	.29	20.1
450	220	155	230	150	220	180	210	90	280	120	235	135	225	165	245	105	14.0	67	81	76	87	.65	.56	.26	19.8
451	223	144	200	120	220	140	270	210	240	120	233	148	210	130	255	165	11.8	57	74	69	86	.38	.38	.22	23.3
452	222	156	190	130	260	200	240	150	240	80	233	140	225	165	240	115	12.6	57	75	68	85	.47	.44	.25	20.5
453	212	148	240	170	200	140	150	90	160	80	188	120	220	155	155	85	12.9	62	69	79	79	.57	.55	.29	17.9
454	185	162	220	200	160	140	150	120	160	120	173	145	190	170	155	120	12.2	70	72	85	75	.51	.42	.20	24.4
455	345	257	270	170	380	300	420	360	520	400	398	308	325	235	470	380	12.2	65	52	97	85	.97	.84	.47	10.6
456	187	100	170	100	220	120	150	30	120	40	165	73	195	110	135	35	13.5	71	50	107	86	1.27	1.17	.58	8.1
457	171	131	160	130	220	160	120	90	160	120	165	125	190	145	140	105	11.9	66	53	99	80	.73	.72	.42	12.3
458	229	86	230	90	220	80	120	30	120	40	173	60	275	85	120	35	15.1	79	65	103	96	1.21	1.27	.51	9.0

Appendix--Continued

459	225	84	210	70	240	100	240	90	200	120	223	95	275	85	220	105	12.7	78	64	103	84	.82	.82	.34	12.6
460	266	116	280	130	220	100	240	90	200	120	235	110	250	115	220	105	15.7	84	59	114	96	1.18	1.19	.39	11.5
461	239	176	240	150	240	200	270	180	280	120	258	163	240	175	275	150	14.5	78	67	100	97	1.18	1.02	.43	11.7
462	254	140	230	130	280	160	420	210	480	280	353	195	255	160	250	245	14.0	68	82	77	80	.57	.57	.25	17.3
463	256	96	230	80	300	120	270	150	280	160	270	128	260	100	280	155	14.3	63	68	80	73	.78	.72	.36	13.8
464	214	97	210	90	240	120	180	120	240	160	218	123	225	105	210	140	14.6	57	77	87	86	.45	.41	.14	28.5
465	145	58	120	50	160	80	150	60	80	80	128	68	140	65	115	70	15.2	61	73	74	76	.66	.70	.26	16.1
466	223	116	150	80	240	20	270	150	320	160	245	128	195	100	295	155	11.4	60	77	70	74	.44	.39	.24	22.4
467	188	98	170	60	200	50	180	120	200	160	188	98	185	55	190	140	18.0	73	78	84	64	.84	.85	.21	22.0
468	177	107	160	80	200	140	180	120	160	80	175	105	180	110	170	100	14.3	72	85	79	47	.74	.69	.30	19.1
469	221	100	220	100	220	100	210	120	200	120	213	110	220	100	205	120	14.9	70	78	81	62	.84	.78	.33	15.6
470	187	123	160	110	220	140	180	120	200	120	190	123	190	125	190	120	11.2	61	83	68	61	.33	.31	.22	24.3
471	125	82	140	80	100	80	120	120	120	120	120	100	120	80	120	120	14.1	65	84	72	57	.72	.59	.28	20.6
472	158	110	170	80	120	80	180	120	160	160	158	110	145	80	170	140	18.2	68	84	76	50	.74	.80	.24	19.4
473	255	163	140	90	260	180	300	180	320	200	255	163	200	135	310	190	19.7	78	129	68	41	1.21	.88	.25	22.8
474	165	158	100	90	140	120	180	180	240	240	165	158	120	105	210	210	18.1	76	119	69	44	.61	.59	.16	28.5
475	95	90	130	120	60	60	90	90	80	80	90	88	95	90	85	85	17.2	79	126	70	38	.86	.87	.30	15.0
476	141	37	130	40	180	60	180	90	200	120	173	78	155	50	190	105	16.4	67	137	58	52	.71	.61	.39	10.5
477	73	59	80	60	80	80	90	90	120	120	93	88	80	70	105	105	16.6	79	108	76	41	.66	.84	.22	20.0
478	178	163	110	90	180	140	180	180	240	240	178	163	145	115	210	210	16.6	74	141	62	56	.54	.48	.15	34.9
479	98	28	70	20	80	20	120	30	120	40	98	28	75	20	120	35	17.3	81	95	83	42	1.27	1.40	.44	9.2
480	75	45	110	50	40	40	60	60	80	80	73	58	75	45	70	70	19.5	57	122	52	70	.73	.68	.29	17.3
481	115	117	160	120	100	100	120	120	120	120	125	115	130	110	120	120	8.8	43	84	48	78	.16	.24	.20	25.4
482	160	80	250	120	300	140	270	120	160	80	245	115	275	130	215	100	7.5	39	73	49	73	.12	.12	.18	23.6
483	195	108	110	50	180	100	210	120	280	160	195	108	145	75	245	140	20.7	82	124	73	57	.73	.74	.17	32.2
484	160	123	130	60	160	150	150	120	200	160	160	123	145	105	175	140	18.0	88	112	83	47	1.04	.91	.28	20.1
485	200	125	170	100	180	120	210	120	240	160	200	125	175	110	275	140	21.9	77	114	72	53	.97	1.08	.27	18.4
486	55	40	70	40	40	40	60	60	40	40	53	45	55	40	50	50	22.6	88	104	86	124	1.00	1.08	.18	24.4
487	141	49	130	50	180	60	180	60	200	80	173	63	155	55	190	70	16.3	78	147	65	39	1.49	1.20	.68	9.9
488	272	105	240	80	380	160	300	180	440	200	340	155	310	120	370	190	15.1	77	146	64	54	.38	.38	.15	23.8
489	160	123	120	80	140	100	180	150	200	160	160	123	130	90	190	155	16.9	79	141	66	34	.46	.44	.12	28.2
490	170	118	110	90	160	40	210	180	200	160	170	118	135	65	205	170	18.7	84	122	75	54	.97	1.03	.31	16.6
491	133	105	110	90	140	120	120	90	160	120	133	105	125	105	140	105	21.4	79	136	67	33	.62	.77	.16	24.6
492	201	120	210	100	200	160	150	150	200	160	190	143	205	115	175	155	15.4	78	89	83	76	.76	.75	.23	20.6
493	85	60	70	60	100	60	30	30	40	40	60	48	85	60	35	35	18.2	84	90	89	56	1.36	1.13	.38	15.3
494	156	110	150	110	180	120	240	150	320	200	223	145	165	115	280	175	14.3	70	97	71	43	.89	.85	.47	14.2
495	234	197	180	140	200	160	210	180	280	240	218	180	190	150	245	210	9.5	63	100	63	65	.13	.12	.05	42.2
496	193	160	160	130	220	180	240	210	280	240	225	190	190	155	260	225	12.8	67	102	66	53	.56	.57	.29	13.9
497	198	103	160	90	180	80	210	120	240	120	198	103	170	85	225	120	17.9	71	102	70	53	1.16	1.02	.42	14.3
498	48	48	30	30	60	60	60	60	40	40	48	48	45	45	50	50	16.7	71	71	87	30	1.27	1.32	.59	8.6

Appendix--Continued

499	50	25	60	30	40	20	60	30	40	40	50	30	50	25	50	35	20.1	70	71	86	43	1.73	1.60	.56	9.2
500	139	57	120	40	220	100	270	150	360	160	243	113	170	70	315	155	15.4	71	90	76	84	.62	.72	.27	16.6
501	141	99	130	80	160	120	150	120	200	120	160	110	145	100	175	120	13.3	71	94	73	57	.51	.50	.23	14.7
502	85	78	50	40	80	60	90	90	120	120	85	78	65	50	105	105	20.5	82	90	88	34	1.46	1.45	.31	16.4
503	78	31	80	40	80	20	60	30	80	40	75	33	80	30	70	35	16.1	71	94	73	56	.79	.41	.28	14.5
504	75	62	70	60	80	60	120	90	120	80	98	73	75	60	120	85	14.3	84	136	71	40	.78	.53	.20	36.3
505	90	90	40	40	80	80	120	120	120	120	90	90	60	60	120	120	17.3	70	61	94	17	1.61	1.47	.59	8.5
506	75	60	50	40	80	60	90	60	60	80	75	60	65	50	85	70	18.1	72	66	93	22	1.65	1.70	.74	6.6
507	102	71	110	70	100	80	120	90	160	120	123	90	105	75	140	105	14.6	51	67	67	26	1.19	.91	.40	12.3
508	123	55	100	50	140	60	150	60	200	80	148	63	120	55	175	70	12.6	72	69	90	33	.56	.65	.34	17.2
509	70	55	80	70	60	40	30	30	40	40	53	45	70	55	35	35	18.7	72	66	93	24	1.53	1.62	.62	7.4
510	123	113	110	90	140	120	120	120	120	120	123	113	125	105	120	120	23.9	90	62	118	64	2.33	2.12	.38	12.5
511	130	110	140	100	120	120	120	120	120	120	125	115	130	110	120	120	19.5	75	54	109	55	1.04	1.05	.15	19.5
512	208	118	170	110	220	120	240	120	200	120	208	118	195	115	220	120	17.6	80	56	113	67	1.22	1.29	.29	12.3
513	280	175	240	150	320	200	240	150	200	160	250	165	280	175	220	155	19.5	80	63	106	71	1.54	1.46	.37	13.0
514	227	119	200	120	240	120	240	180	160	160	210	145	220	120	200	170	16.1	78	70	97	71	1.08	.96	.29	16.5
515	125	75	110	70	140	80	60	60	80	80	98	73	125	75	70	70	19.3	73	63	97	54	1.10	1.07	.21	16.2
516	118	114	120	110	100	100	120	120	160	160	125	123	110	105	140	140	11.6	62	48	99	73	.58	.55	.28	14.4
517	157	137	150	130	160	140	180	150	160	120	163	135	155	135	170	135	13.9	62	51	94	62	.88	.79	.32	14.1
518	147	131	150	130	140	120	50	150	160	160	150	140	145	125	155	155	12.4	59	46	97	56	.64	.62	.29	17.0
519	122	96	120	100	140	100	150	90	200	120	153	103	130	100	175	105	14.6	75	60	103	64	.97	.92	.37	12.6
520	210	172	230	190	180	140	210	180	240	200	215	178	205	115	225	190	12.8	69	63	91	90	.64	.63	.27	20.8
521	187	91	140	60	200	100	180	60	200	120	180	85	170	80	190	90	9.6	68	51	103	70	.51	.57	.40	10.0
522	97	57	110	80	120	60	60	30	80	40	93	53	115	70	70	35	11.2	56	66	73	90	.63	.47	.48	8.7
523	335	243	310	220	320	240	390	270	320	240	335	243	315	230	355	255	10.4	62	63	83	79	.52	.57	.29	11.7
524	156	84	150	90	160	80	150	90	160	80	155	85	155	85	155	85	9.9	47	65	63	72	.44	.41	.52	8.4
525	155	98	140	80	200	100	120	90	160	120	155	98	170	90	140	105	10.3	58	49	91	65	.58	.54	.44	9.8
526	98	63	100	70	80	40	90	60	120	80	98	63	90	55	105	70	18.2	74	80	84	51	1.34	1.43	.45	8.9
527	65	15	70	10	60	20	30	30	40	40	50	25	65	15	35	35	23.1	76	96	76	27	2.42	2.29	.53	8.3
528	50	50	20	20	40	40	60	60	80	80	50	50	30	30	70	70	17.7	73	135	63	7	1.16	1.18	.49	9.7
529	50	25	60	30	40	20	60	30	40	40	50	30	50	25	50	35	22.9	78	137	64	21	1.66	1.70	.30	11.5
530	78	50	40	20	60	40	90	60	120	80	78	50	50	30	105	70	19.4	74	136	62	33	.90	1.03	.41	10.9
531	377	234	260	140	400	260	390	270	360	200	353	218	330	200	375	235	9.0	43	58	63	88	.27	.25	.32	13.2
532	433	313	300	190	340	220	390	270	480	360	378	260	320	205	435	315	8.9	45	59	65	92	.25	.29	.34	12.3
533	133	109	120	70	140	100	150	120	120	120	133	103	130	85	135	120	9.7	43	66	57	51	.31	.33	.44	9.1
534	81	54	90	60	80	60	60	30	80	40	78	48	85	60	70	35	12.5	47	42	64	43	1.02	.96	.57	7.7
535	320	196	300	170	280	160	360	240	360	240	325	203	290	165	360	240	10.9	48	60	67	72	.50	.50	.52	8.4
536	75	70	70	60	80	80	60	60	40	40	63	60	75	70	50	50	25.5	120	80	135	58	3.28	3.50	.56	9.5
537	229	78	190	80	240	60	240	60	120	40	198	60	215	70	180	50	16.5	85	47	130	87	1.77	1.69	.50	8.9
538	205	115	210	110	200	120	150	120	80	80	160	108	205	115	115	100	21.8	95	47	143	78	2.30	2.42	.64	8.1

Appendix--Continued

539	258	112	260	120	260	120	270	120	280	120	268	115	260	110	275	120	15.4	83	47	127	77	1.62	1.54	.53	9.0
540	261	134	270	130	240	120	330	210	320	160	290	155	255	125	325	185	14.4	81	48	123	77	1.41	1.32	.52	9.4
541	303	180	230	150	260	160	330	210	400	200	305	180	245	155	365	205	10.5	69	46	110	82	.54	.53	.28	15.3
542	185	25	130	10	160	20	210	30	240	40	185	25	145	15	225	35	19.7	87	69	109	59	1.56	1.47	.35	11.5
543	170	10	130	10	200	20	150	30	80	40	140	25	165	15	115	35	16.4	70	78	81	87	.94	.87	.35	14.0
544	148	90	90	40	120	80	180	120	200	120	148	90	105	60	190	120	16.7	74	97	75	38	.73	.73	.23	14.4
545	193	183	170	150	180	160	180	180	240	240	193	183	175	155	210	210	21.2	113	99	113	51	.83	.90	.26	17.3
546	73	58	60	50	60	40	90	60	80	80	73	58	60	45	85	70	21.9	110	87	119	35	2.91	1.90	.51	9.5
547	168	148	150	110	180	140	180	180	160	160	168	148	165	125	170	170	18.1	104	86	113	49	1.11	1.35	.27	14.1
548	175	110	210	140	140	80	90	30	120	40	140	73	175	110	105	35	24.0	102	88	109	44	1.76	1.62	.18	21.5
549	233	140	170	120	280	200	240	120	240	120	233	140	225	160	240	120	18.0	102	82	114	49	.66	1.05	.18	20.7
550	180	155	150	140	160	140	210	180	200	160	180	155	155	140	205	170	21.9	102	89	109	54	1.69	1.49	.28	20.3
551	238	183	190	150	200	160	240	180	320	240	238	183	195	155	280	210	22.6	100	93	104	45	1.59	1.57	.25	17.1
552	180	155	120	110	180	160	180	150	240	200	180	155	150	135	210	175	29.0	107	89	114	46	2.24	2.32	.31	14.6
553	150	150	130	130	160	160	150	150	160	160	150	150	145	145	155	155	17.3	109	52	153	72	1.78	1.72	.37	13.0
554	210	210	120	120	200	200	240	240	280	280	210	210	160	160	260	260	28.1	123	51	171	62	4.90	4.66	.64	8.4
555	195	193	170	160	160	160	210	210	240	240	195	193	165	160	225	225	19.8	108	48	157	58	3.04	3.87	.65	6.5
556	233	202	190	170	280	240	300	240	360	280	283	233	235	205	330	260	13.2	101	49	147	70	.98	.99	.30	16.3
557	260	233	180	160	240	220	300	270	320	280	260	233	210	190	310	275	17.8	103	44	157	82	1.59	1.58	.24	13.9
558	210	185	240	210	180	160	180	188	200	200	200	188	210	185	190	190	32.1	134	97	136	74	2.90	2.78	.24	14.4
559	265	258	230	220	280	260	270	270	280	280	265	258	255	240	275	275	20.9	140	80	157	73	1.80	1.62	.23	23.9
560	315	285	250	220	280	260	330	300	400	360	315	285	265	240	365	330	22.4	118	89	126	70	1.00	1.00	.12	31.5
561	338	285	260	250	340	280	390	330	360	280	338	285	300	265	375	305	35.8	154	97	156	77	2.80	2.65	.26	15.9
562	275	245	180	150	260	240	300	270	360	320	275	245	220	195	330	295	27.8	136	96	139	67	2.25	2.36	.21	18.9
563	215	195	270	230	160	160	150	150	120	120	175	165	215	195	135	135	22.7	102	94	106	54	1.80	1.67	.31	13.5
564	235	208	180	160	200	180	240	210	320	280	235	208	190	170	280	245	19.6	102	49	147	72	2.65	2.43	.54	9.6
565	256	185	250	180	280	220	180	180	240	240	238	205	265	200	210	210	15.7	89	48	133	73	1.51	1.39	.47	11.5
566	160	133	150	130	140	120	150	120	200	160	160	133	145	125	175	140	20.5	92	56	127	55	1.37	1.51	.43	11.0
567	165	138	140	120	140	120	180	150	200	160	165	138	140	120	190	155	16.7	83	51	123	74	1.37	1.27	.35	13.0
568	195	165	150	130	240	200	180	120	160	120	183	143	195	165	170	120	22.7	98	50	141	81	3.31	2.88	.61	9.0
569	175	160	170	150	200	180	180	180	80	80	158	148	185	165	130	130	12.0	55	53	83	78	.65	.56	.41	13.3
570	138	79	120	70	160	80	180	120	160	80	155	88	140	75	170	100	14.4	63	53	94	51	.86	.86	.37	11.9
571	186	110	180	100	180	120	210	120	200	120	193	115	180	110	205	120	12.5	69	60	94	67	.65	.58	.30	14.4
572	163	93	200	130	260	140	180	90	120	80	190	110	230	135	150	85	9.0	49	50	77	75	.26	.25	.26	17.2
573	205	170	120	110	180	160	210	180	200	160	178	153	150	135	205	170	8.8	44	54	67	75	.21	.20	.22	17.4
574	173	156	190	170	180	160	240	210	280	240	223	195	185	165	260	225	16.4	136	96	139	80	2.05	1.53	.44	23.4
575	243	210	210	190	200	160	240	210	320	280	243	210	205	175	280	245	22.8	134	97	136	72	2.00	2.00	.32	15.3
576	168	160	200	170	120	120	150	150	200	200	168	160	160	145	175	175	27.5	168	92	174	73	5.58	3.85	.38	12.2
577	211	192	200	190	240	200	270	240	280	240	248	218	220	195	275	240	15.5	125	98	126	68	.95	.75	.18	30.4
578	225	180	230	180	220	180	240	180	200	160	223	175	225	180	220	170	17.6	120	92	126	69	1.07	1.00	.19	27.4

Appendix--Continued

579	228	149	200	140	260	160	240	150	240	160	235	153	230	150	240	155	12.2	81	73	99	70	.65	.62	.30	20.1
580	103	83	110	90	100	80	60	60	80	80	88	78	105	85	70	70	14.4	78	83	87	72	.92	.89	.37	12.8
581	125	110	110	100	140	120	90	90	80	80	105	98	125	110	85	85	15.7	73	70	90	88	1.01	.86	.42	11.9
582	255	180	290	180	320	220	180	150	200	160	248	178	305	200	190	155	10.8	69	65	90	93	.51	.48	.34	16.3
583	214	149	210	150	240	160	180	120	240	160	218	148	225	155	210	140	13.6	77	66	100	91	.70	.74	.32	17.3
584	218	134	210	130	240	140	210	120	240	120	225	128	225	135	225	120	14.6	67	67	85	90	.74	.65	.26	21.8
585	140	120	150	120	120	120	120	120	120	120	128	120	135	120	120	120	15.9	73	69	91	91	.91	.89	.32	17.4

1/ As measured or modified for different portions of the stand surrounding each sample tree, using the angle gauge with different basal area factors, and given in square feet per acre. See text for complete explanation of each expression. Values for the "total" stand and the "D + C," dominant and codominant, portions are shown. Variables X_3, X_6, X_9, X_{12}, X_{15}, X_{18}, X_{21}, and X_{24}, for the "I + S," intermediate and suppressed, portion of the stands are not tabulated as they can be obtained readily by subtracting the values for the D + C portion from that of the total in each case.

EXPLANATION OF STAND CONTROL INFORMATION (unpublished)

An effort is made to convert the findings of the three published papers into a simplified program for ponderosa pine management that can be applied by many small woodland owners.

It is assumed that: (a) precommercial thinning will not be generally applicable, and (b) the dominant and codominant stand must have attained an average d.b.h. of 10 inches before commercial thinning will be practiced to any appreciable extent.

The approximate age at which the dominant and codominant portion of unmanaged well-stocked stands on soils of different site quality, reach an average d.b.h. of 10 inches is shown in Fig. 102 and Table 103.[1/] Beginning at this time with appropriate recurring thinnings, the average diameter growth of the residual stands will proceed as shown in Fig. 102.

Appropriate thinning interval lengths for the different site classes are shown in Table 103. (Forest Science 9:(1) 33-43, March, 1963. These thinning interval lengths, and the diameter-age curve is Fig. 102, will apply no matter what thinning rule is used, so long as the thinning is adequate. Operable amounts of material may be expected to be available at each thinning to justify operations when the thinning interval lengths specified for the different site quality classes are used.

When a diameter-based spacing rule is used as a guide in thinning, and the course of diameter growth is known as indicated in Fig.102, it is possible to predict the approximate number of trees left per acre

1/ Statistics for these stands are available from Table 7 and Figs. 5, 6, and 7 in an earlier section of the material presented herewith.

at each thinning and at the end of the rotation. This is exemplified for site index 80 in Table 101. For ready reference the information is often presented by curves showing the approximate number of trees per acre over diameter for the diameter-based rule employed. The number is fixed approximately by the rule at the time of the preceding thinning and the diameter at that time must be used in predicting the number of trees remaining per acre (it being assumed that recurring thinnings prevents mortality losses during the thinning cycles).

Woodland planning for continuous production must include a consideration of appropriate regeneration cuttings. This may be done in ponderosa pine by group selection methods designed to meet the silvicultural requirements of the species. That is: (a) openings need to be made large enough to promote regeneration and growth. (b) seed sources or advanced reproduction, or planting must be adequate to regenerate the openings, (c) seedbed conditions must be satisfactory, and (d) hazards from fire, insects, animals and competing vegetation need to be considered. The minimum size of regeneration openings is assumed to be about 100 feet across.

This procedure is called crop-tree harvesting and it is convenient for woodland owners to control the total amount of such cutting on their enterprises by keeping track of the number of crop trees harvested in this manner for regeneration purposes. It is also convenient for them to plan this work so that it follows each thinning. It should be considered as a separate procedure and should not be confused with the thinning operations. This is a simple way of controlling the area of clearcutting to regenerate the right amount at each thinning.

The rate of crop tree harvesting to provide the proper age-class distribution is dependent upon the length of the rotation and the number of crop trees per acre that are expected to be available at the end of the rotation. Table 102 exemplifies this information for site index 80 where two diameter-based spacing rules have guided the thinnings.

Harvesting one crop tree per acre per year fixes the rotation length for different site quality classes. By plotting information exemplified in Table 102 and reading the age at which the curves cross the "one crop tree per acre per year" rate, the approximate rotation age is obtained. Rotation ages have been taken from Fig. 101 and summarized with other stand control information in Table 103.

Information in Table 103, Fig. 101, and a standard soil survey with woodland interpretations are a basis for establishing a woodland plan. This simplified program can be fitted to any set of woodland conditions that may be encountered. It is flexible with recpect to owner-operator wishes, and his management decisions dictated by economic conditions.

Table 101. Stocking control of hypothetical even aged ponderosa pine stands at site index 80 following thinning regimes with two spacing formulae *

Age at thinning	After thinning $(D+6)^2$ every 12 years			After thinning $(D+2.1)^2$ 1.70 every 12 years**		
	Number trees per acre	Average diameter (inches)	Average basal area per acre (sq. ft.)	Number trees per acre	Average diameter (inches)	Average basal area per acre (sq. ft.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
56 (first thinning)	170	10.0	93	197	10.0	107
68	142	11.5	102	154	11.5	111
80	125	12.7	110	129	12.7	113
92	110	13.9	116	109	13.9	115
104	100	14.9	121	96	14.9	116
116	90	16.0	126	85	16.0	119
128	83	16.9	129	77	16.9	120

*Explanation of numbered columns:

(1) Starting age is that at which the tree of average basal area in the dominant and codominant portion of normal, unmanaged stands reach 10 inches (considered large enough to be a commercial thinning). Successive ages are derived from the uniform thinning interval of 12 years.

(2 and 5) Number of trees left after tninning (assumed to be present at the end of the thinning cycle 12 years hence). Obtained by applying the spacing rules for diameters shown in columns 3 and calculating, i.e., $43560/(D+6)^2$ or $43560/(D+2.1)^2$ 1.70.

(3 and 6) Read from curves in Fig. 102 representing average diameters of trees made free to grow by appropriate recurring thinning beginning at the starting age.

**This is the biological spacing formula, $S = (D+X)^2F$. The value for X was interpolated from curves for the 12-year thinning interval (see Fig. 4/, Lenmon and Schumacher, 1963/). The value for F was read from curves to the nearest hundredth (see Fig 2/ in the same publication).

Table 102.--Required rates per acre per year of crop tree harvesting at the time of last thinning, to develop proper age-class distribution, assuming a rotation to the end of the 12-year thinning cycle in each case. Site index 80.

Age at last thinning	Assumed rotation length	Numbers of crop trees to harvest per acre per year according to spacing formulae used 1/	
		$(D+6)^2$	$(D+X)^2F$ 2/
56	68	2.50	2.90
68	80	1.78	1.93
80	92	1.36	1.40
92	104	1.06	1.05
104	116	0.86	0.83
116	128	0.70	0.66
128	140	0.59	0.55

1/ Number of residual trees per acre divided by the assumed rotation age.

2/ The biological spacing rule $(D+2.1)^2 1.70$

Table 103.--Stand control of ponderosa pine by [illegible]

Item [1/]	Site index										
	60	70	80	90	100	110	120	130	140	150	160
1. Approximate age when tree of average basal area reaches 10 inches ---------- years	82	69	56	48	40	35	29	25	22	19	15
2. Thinning interval ---------- years	20	15	12	10	9	8	7	6	5	4	3
3. Approximate rotation, International rule ---------- years	122	114	104	98	94	83	78	67	57	51	39
4. Approximate diameter of crop trees at rotation age when released by recurring thinnings ---------- inches	13.0	14.4	14.9	16.0	17.5	18.4	20.4	22.0	24.3	27.0	28.6

[1/] Explanation of numbered items as follows:

(1) Approximate age at which the tree of average basal area in the dominant portion of a normal, unmanaged stand reaches 10 inches (considered a time of first commercial thinning - See Fig. 5).
(2) Thinning interval length suitable for $(D+6)^2$ spacing (Lemmon and Schumacher, 1963a).
(3) Established when reproduction openings are made by clearcutting at the rate of one crop tree per acre per year following each thinning (Figure 101). These values represent the approximate number of crop trees per acre on even-aged areas at the ends of rotations.
(4) Read from curves in Fig. 102.

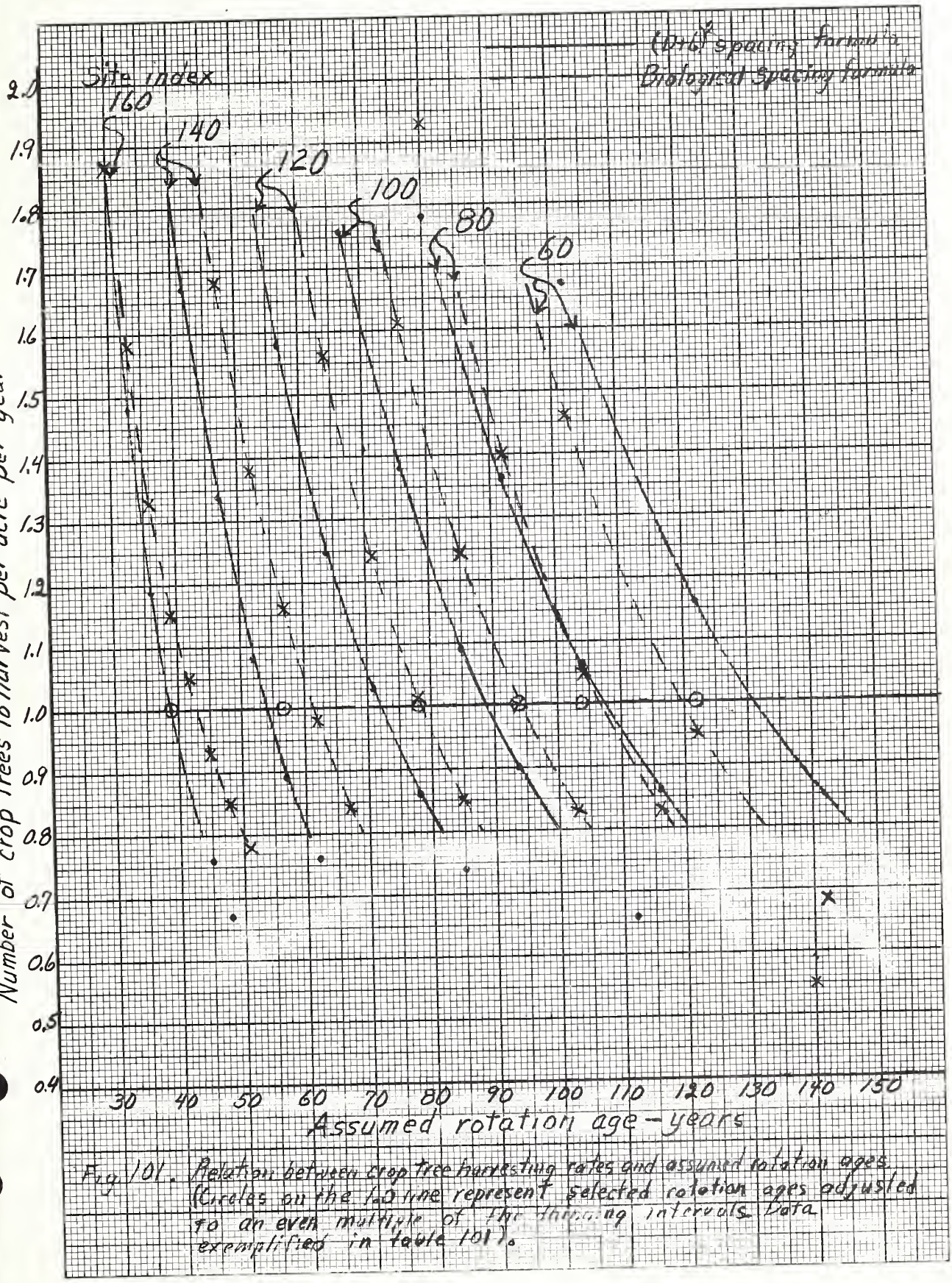

Fig 101. Relation between crop tree harvesting rates and assumed rotation ages. (Circles on the 1.0 line represent selected rotation ages adjusted to an even multiple of the thinning intervals. Data exemplified in table 101).

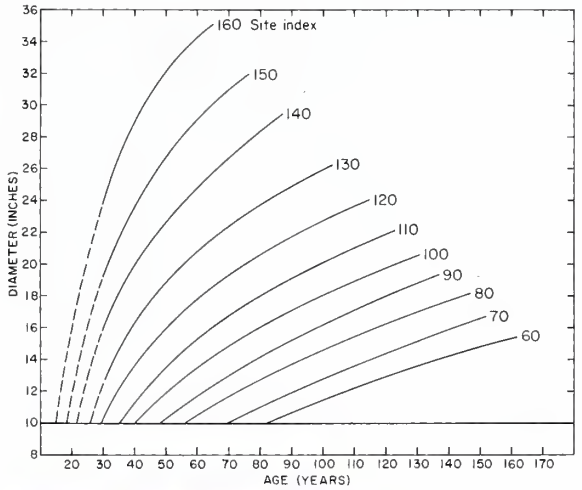

Figure 1.32 [illegible] Calculated diameter growth of dominant ponderosa pine trees on different sites when freed to grow, accordingly, beginning at 10 inches d.b.h.